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MAY, 1960 VOL. 25, NO. 8
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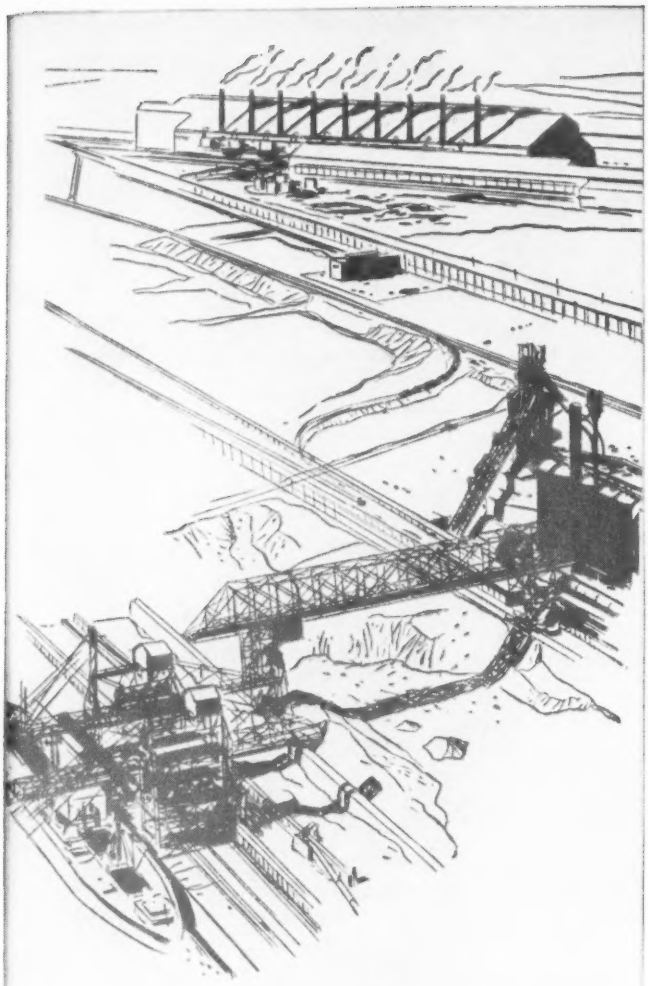

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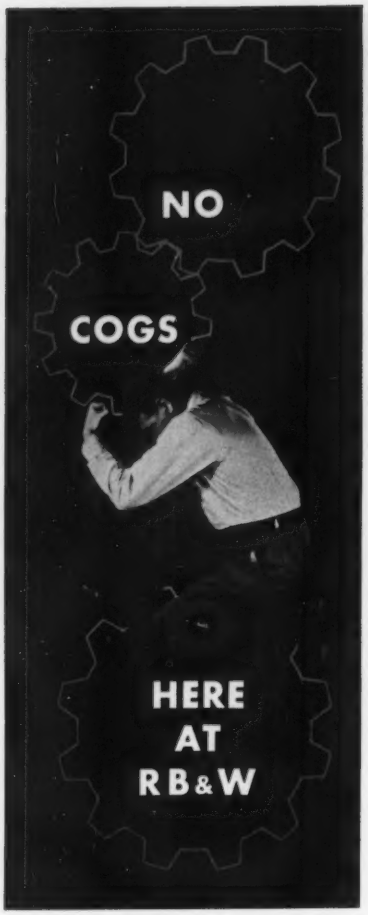

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Editorial . . .

ENGINEERING EDUCATION

A MERE BEGINNING

Engineering education is not an end. It is a beginning for the program of continuous self education that is a life-time project for a good engineer. How many times we have heard statements like this! And yet do we fully comprehend their meaning? All too often the implication is simply that the engineer should keep abreast of his field by reading technical journals. This is necessary of course, but the engineer should also broaden himself. He should not only attempt to improve his understanding of other engineering fields but also to pursue the liberal studies which were slighted in his formal education.

Technical Study Necessary

One can no longer hope to cover fully the whole field of engineering, or even one aspect of the field, in the four or five years of formal education. Because of this, engineering education teaches an approach rather than a study of this material or that technique. When the student graduates he will find that his schooling has not acquainted him with all the developments he will need to know to do his job, but only the method of approach and the ability to use information when he finds it. It will be necessary that he spend some time reading about recent developments as they pertain to his problems. Today a new product appears on the market every day, and man takes a step farther into space every month. Even if the formal education could cover all the information necessary to the engineer it would be partly obsolete the week after graduation. Certainly the good engineer would have to keep up with these developments.

The engineer must also be careful to include the other fields of engineering in his program of self education. Specialization is necessary, but overspecialization based on the idea that one team may work on one aspect of a project and another on some other aspect should be avoided. Can two people, knowing nothing of each other's approach or problems cooperate to turn out one working product? They cannot. They will have to have some idea of what the other can do and what his limitations are.

Liberal Studies

Engineers of today create powerful tools which will shape the future. Atom power, rocket engines, electronic 'brains', and machines designed to translate books from a foreign language are but a few examples. Huxley's *Brave New World* is no further away now than *Around the World in Eighty Days* was in Verne's day. The power to radically change society is being developed. And what will control it? Certainly this will demand the imagination and ability of the student of the liberal arts; the sociologist, the psychologist, and the historian. These people have studied the relations of human mind to its environments. But can we delegate the responsibility to make all decisions on technical matters to a group of specialists who have no sensitivities to the problems and approach of the liberally educated? Obviously to cooperate with these people the engineer will need some understanding of their problems.

Necessity dictates engineering curriculum. In order to develop the approach necessary the liberal studies must be slighted, and the engineer will have to pursue these later—on his own.

Dean Dale R. Corson, in an article for the Cornell Engineer, points out that engineering is characterized by responsibility to the public. He said "He must be sure that his product will perform the job to be done, will be producible, will be easy to service." This is no easy job. To be sure that a product will do its job the best way possible the engineer will have to keep abreast of the new developments within his field. Furthermore, to cooperate with those in other fields of engineering and those liberally educated who will be concerned with the problems of society, he must strive to broaden himself as much as possible. We hope that each engineering graduate will remember his responsibility and will strive in every way to keep his education adequate to meet the needs of his changing society.—RTF

Dear Reader: We want to please you but we must know what you want and like. If you have any suggestions or comments we would be glad to receive them. Letters should be sent to Editor of the Engineer, 1 Carpenter Hall, Cornell University, Ithaca, New York.

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THE CORNELL engineer

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Science helps answer the need for better materials with . . .

FIBERGLASS FOR STRONGER PLASTICS

by Joel Lichtenstein, EE '64

Fiberglass reinforced plastic, a new type of material formed by the combination of glass fibers and plastic resins, has proved to be an important solution to the materials problem faced by modern science.

The wide variety of unreinforced plastics which were developed early in the century were useful because of their great moldability. However, they could not possibly answer the jet age's need for a light, moldable material with the strength of steel or aluminum alloy.

Fiberglass, developed in the 1930's, is commonly used as glass wool insulation and, in a woven form, as fireproof cloth. It was discovered that impregnating chopped strands or flexible woven mats of this glass with certain plastic resins resulted in a material with the strength of most metals, the light weight of magnesium, and many of the molding properties of plastics. These properties made fiberglass reinforced plastics useful in many fields as a replacement for metals.

But fiberglass reinforced plastic has many favorable properties which make it useful, not only as a replacement for metals, but also as a new structural medium. It is an excellent insulator for both heat and electricity; it does not have the radio shielding effects of metals; it is almost unaffected by water and most chemicals; and it can be either permanently colored or made translucent. These properties make fiberglass reinforced plastic applicable for a multitude of uses, especially in the construction and aircraft industries.

One of three Fiberglas-reinforced plastic pavilions erected at the U.S. fair in Moscow last summer. Muscovites are seen enjoying the protection from the bright sunlight that is afforded by the translucent structure. Similar pavilions were used to house the architectural, photographic and live fashion shows.

Glass Properties

The use of glass reinforcement gives the plastic increased strength, stiffness, and resistance to shock, and a wider useful temperature range. The direction of the glass strands may be varied to give the plastic any desired directional strength. Since the form of glass fiber used can be varied more easily than the type of plastic resin, it is the glass that is usually used to determine the characteristics of the final product.

The chemical and physical properties of fiberglass do not differ appreciably from those of hardened bulk glass. Rather, it is in mechanical properties that the difference between the two forms lies. Fiberglass has a much greater tensile strength than bulk glass. In fact, for its weight it is one of the strongest structural materials known. However, because of its large surface-to-volume ratio, it is more susceptible to weathering than bulk glass. Fiberglass differs from metals in that it does not change properties with working.

Fiberglass is manufactured by forcing molten, soda-free glass through small holes in a melting furnace, thus attenuating the glass into extremely thin filaments. These filaments are then gathered into strands, which can be either chopped up or spun into yarn. The final step in the manufacture of fiberglass for use in plastic reinforcement involves the application of a finish sizing which aids plastic adhesion, an important strength factor.

Plastic Resins

The plastic resins serve at least as important a function as the glass fibers. The resins impart to the finished material its moldability, finish, and most of its chemical properties. The plastic also serves as a filler between the glass fibers.

Plastics can be divided into two classes, thermoplastic resins and thermosetting resins. Thermoplastic resins, such as polystyrene and polyvinyl chloride, undergo no chemical change upon heating. They do, however, soften when heated, but since this change is only physical, the recooled material does not differ in properties from the original resin. These plastics are often flame resistant and economical, but are seldom used with fiberglass reinforcing because of their low resistance to heat.

The thermosetting resins are a class of plastics which "cure" or harden permanently under the combined effects of heat, pressure, and a catalyst. A chemical reaction occurs resulting in polymerization of the short chain hydrocarbons. Once cured, repeated heating within certain limits will have no effect on the plastic.

There are a multitude of different thermosetting resins commercially available that are used for fiberglass reinforced plastics. The specific resin used is determined by its chemical, thermal, and electrical properties, strength, resistance to corrosion, water absorption, adhesion to glass, and color properties. The type of catalyst, molding pressure, and curing temperature are also factors that are taken into consideration when planning for production economy.

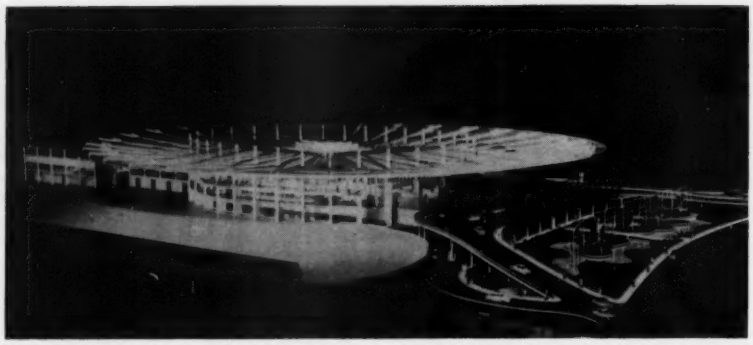
Polyesters

The most popular resins for use in fiberglass reinforced plastics are the polyesters. They are easily produced by controlled reactions of organic acids and complex alcohols. Polyesters are clear or straw-colored, and have favorable

chemical and physical properties for use with fiberglass reinforcement. Their upper useable temperature limit ranges from 200F to 500F. Major limitations are their flammability and shrinkage upon curing (up to 4–5 per cent).

Curing conditions of these resins are dependent upon the catalyst used. Curing time ranges from 75 seconds to 30 days, temperature from 70F to 300F, and pressure from atmospheric pressure to 300 lb per sq in. Polyesters can utilize quick, low-temperature-low-pressure curing, another reason for their widespread use.

Other thermosetting plastics are sometimes used with fiberglass reinforcing when their special properties make them superior to polyesters. The epoxies, for example, have low shrinkage and good adhesion properties, but they are difficult to extract from molds. Phenolic resins are inexpensive and have favorable chemical properties, but they are naturally brown or black, and therefore hard to dye successfully. Silicone plastics have high heat resistance, but are too expensive for general use. Therefore, the best resins for general use still seem to be the polyesters.



A series of 30-ft long Fiberglas-reinforced plastic skylights is being installed in the circular roof of the new Pan-American Airways building at N.Y. International Airport, scheduled to open this year.

Molding

Once a suitable glass fiber and appropriate plastic resin have been chosen, they must be combined and shaped to form the final product. This can be accomplished by any of several molding methods. The plastic-glass combination is extremely easy to mold, even under conditions of low temperature and pressure. This ease of molding permits production of large parts up to 50 feet long and several feet wide on a single mold. The choice of molding method depends upon the nature of the product and the quantity to be manufactured. For example, large runs of small parts often can be made most economically on matched metal dies, while for small quantities of large parts, low pressure hand-laminated techniques are usually preferable.

Contact molding is the simplest and cheapest method of producing small quantities of parts. The fiberglass is placed, or layed up, by hand on an open contour mold, and the resin is then sprayed or painted on. The combination is then allowed to harden without application of heat or pressure.

In the vacuum bag and pressure bag methods, the resin and the glass fiber are placed in the mold in the same way as in contact molding. The mold is then covered with a thin polyvinyl bag, and low pressures are applied to the material, either by vacuum or by air pressure. The entire molding operation is sometimes set up in an oven to permit simultaneous application of heat and pressure.

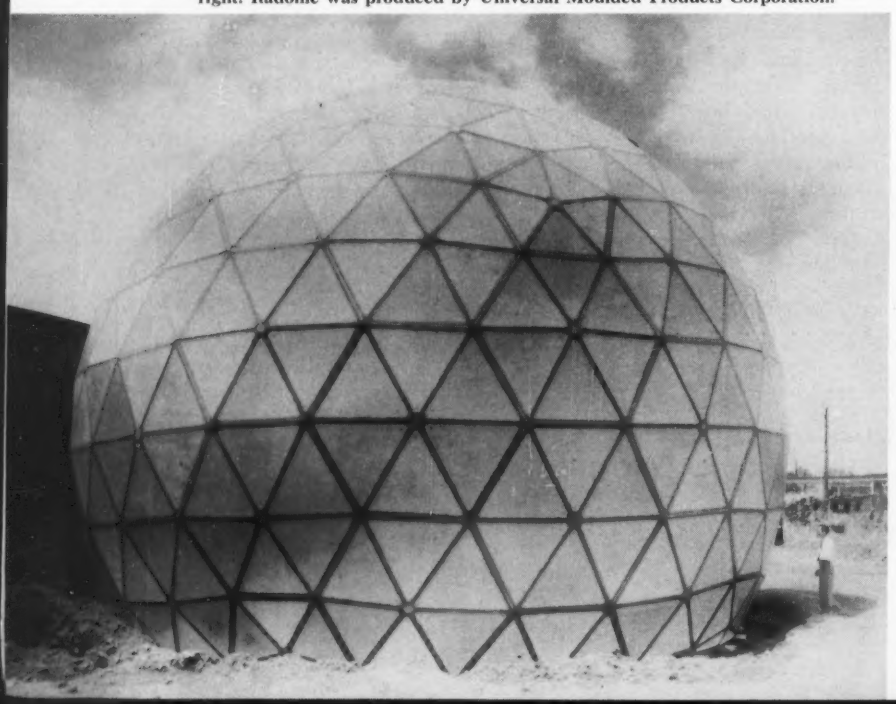
Flexible plunger molding is analogous to the die casting of metals. The glass-resin combination is layed up in a heated metal cavity and a plunger is used to obtain relatively high pressures. High glass-to-plastic ratios can be obtained using this method.

Matched die molding is often used for manufacturing large quantities of relatively small parts. The matching mold cavities are heated and the plastic-glass combination is put in place. The dies are then closed to apply pressure during curing.

In preform molding, a shaped mold with small holes in it is attached to a vacuum pump. Chopped strand fiberglass is matted over the mold and sprayed with liquid resin. The partial vacuum inside the mold draws the resin through the glass, thereby thoroughly impregnating it.

The use of these various molding techniques makes possible the production of complexly-shaped pieces which would be impossible to stamp out of metal.

Impressive size of this Fiberglas-reinforced plastic radome produced for the NATO Early Warning Defense System in Europe is pointed up by comparison with man at right. Radome was produced by Universal Moulded Products Corporation.



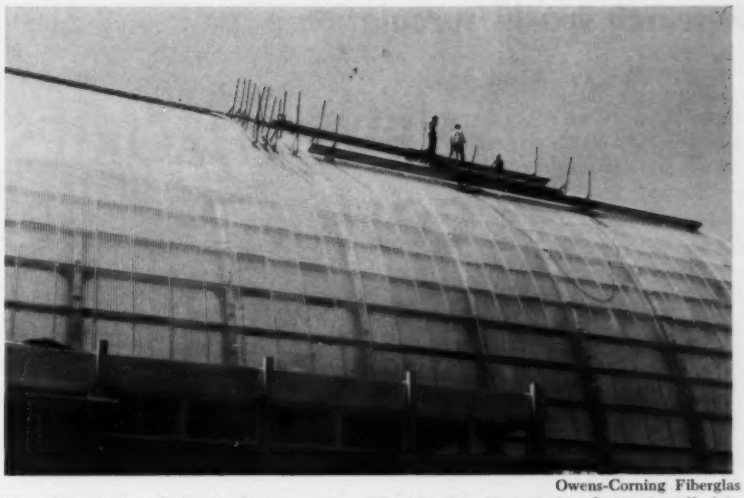
Applications

By using different combinations of molding method, fiberglass, and

plastic, an endless variety of products can be obtained. These products have a correspondingly large variety of uses.

One of the most common uses of fiberglass reinforced plastic is in translucent building panels. Panels made of this material are lightweight, strong, shatter-proof, and weather-proof. They are easily installed since they can be sawed and fastened like wood and require none of the special mountings needed with plate glass. The covering for the entire patio-lounge of the recent American National Exhibition in Moscow was constructed of fiberglass segments.

Other uses of fiberglass are in the hulls of small boats and in sports car bodies. Many other consumer items, such as furniture, appliances, and toys, are making use of this material. The New York City Transit Authority spent $630,000 last year to equip over 600 busses with reinforced fiberglass seats.



Owens-Corning Fiberglas

Fiberglas-reinforced plastic sheets, produced by Kemlite Corporation, being installed in the roof of the new $540,000 Palm House of the Garfield Conservatory in Chicago. The building, the largest of its kind in the world, will utilize 40,000 square feet of the panels.

Aircraft Industry

The greatest use for fiberglass reinforced plastic, however, is in the aircraft industry. It is used on the exterior of a plane for radar and radio antenna enclosures and critical wing and tail sections. Internally, it is used for air duct systems, cabin furnishings, protective instrument shrouds, insulation for foot rests, and literally hundreds of other minor uses. Its chemical inertness and high heat resistance make it useful for fuel tank mountings, engine ducts, and high temperature insulation for electrical wire. One new plane, the Fairchild F–27, uses reinforced plastic in some 450 different applications.

Economy

Parts made of fiberglass reinforced plastic are on about the same price level as those made of aluminum. They are less expensive than many machined metal parts. Side benefits also contribute to the economy of this material. Because a whole assembly can be made of one or two parts, fabrication and tooling requirements are greatly simplified. When its superior chemical and physical properties are considered, it is able to rival economically almost any other material. This great economy of fiberglass reinforced plastic plus its amazing variety of forms account for its increasingly popular use.

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Fiberglas-reinforced plastics find many uses in planes such as this Douglas DC-8. Their light weight and great strength make reinforced plastics especially useful in the aircraft industry.

Research sparks speculation on . . .

NEW THEORIES OF COLOR PERCEPTION

by Delia A. Corkey, EP '64
and
Benson J. Simon, Arts '61

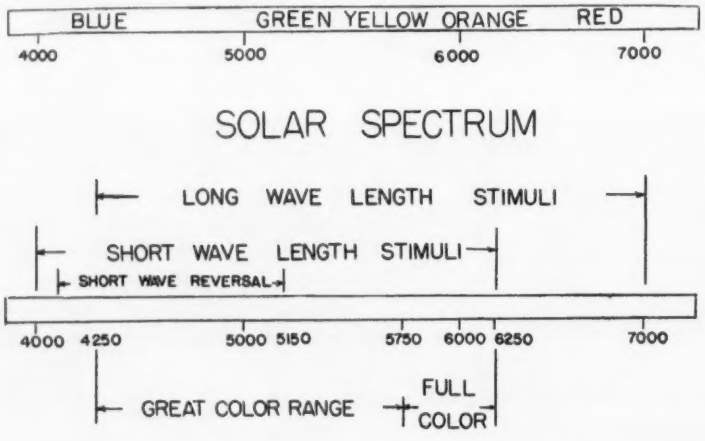
Five years ago, Dr. Edwin H. Land of Polaroid undertook a series of experiments in color perception which seemed to shake the foundations of classical color theory. His work received wide popular attention after articles on it appeared in *Fortune* and *Scientific American* last May. Since then, several papers have been published which attempt to show that his startling experimental results are not in conflict with the older theories. Whether or not his discoveries necessitate development of a new theory of color perception still remains to be seen. If his color reproduction system can be perfected and adapted to commercial use, it could have far-reaching effects on many fields of technology.

Many Theories Advanced

Color in pigment and color in lights is obtained in different ways. Pigment color is obtained by the use of "subtractive" primaries, generally blue, yellow, and red. The combining of these in various concentrations gives all the other hues, and a combination of the three gives black. Color in lights is obtained by use of the "additive" primaries: blue, red, and green. Combining these gives all other hues and a combination of the three gives white. Control of color and brilliance by the blending of pigments is well known to anyone who has ever mixed paints. However, recent experiments have revealed many gaps in our understanding of color in light and in projected pictures.

Throughout history, man has speculated about the nature of color. The French philosopher-mathematician Rene Descartes believed color to be a metaphysical property of objects that is perceived when there is light on the object, although color itself is a property independent of light. He thought that color changed relative to the "spin velocity" of the light particles. In 1672, Sir Isaac Newton published his discoveries about color. He was the first to use a prism to break up sunlight into its color components. From the different colors in the spectrum, he concluded that "Light consists of Rays differently refrangible," and that "to the same colour ever belongs the same degree of refrangibility."

The first theory of three primary colors was advanced by Lomonosov. He believed that there were three kinds of light parts, but his theory was not widely accepted. The theory that there was an infinite number of colors was advanced by D'Alembert in 1764 and was accepted until the publication in 1802 of a paper by Thomas Young. In his paper, Young described the physiological effects of color on the retina. In 1856, a German physicist expanded Young's findings into what is now



Delia A. Corkey

Upper portion of the diagram shows the colors in the classical Newtonian spectrum along with their wavelengths in angstrom units. Lower portion shows an evaluation of the perceived spectrum in terms of Land's experiments with two-color projections. Areas marked off above the wavelength values show the segments of the spectrum that can serve as long- and short-record stimuli. Reversal area in which the records must be interchanged is also shown. Summary of corresponding range of observable colors is shown below. Refer to the long-wave—short-wave color map on page 16 for a fuller representation.

Benson J. Simon

Shown above is a pair of "color separation pictures" which, when made into postive-transparencies, can be used to demonstrate two-color reproduction. Red and blue cellophane served as the filters, the upper picture being the long-wave (red-filtered) record. The fan-shaped array of colored papers on the left contains, clockwise from the top, orange, brown, blue, white, red, black, yellow, and green paper. Note the relative differences between the shades of gray that these colors cause in the two filtered monochromes.

known as the Young-Helmholtz theory of color vision.

Young-Helmholtz Theory

According to this theory, three sets of receptors in the eye are stimulated to different degrees by each wavelength of the visible spectrum. Mixtures of these wavelengths stimulate receptors so that certain predictable colors will be observed. Although this theory did not explain color relationships thoroughly, it provided a reasonable explanation of color perception.

The Young-Helmholtz theory states that there are three primary colors: red, blue-green, and blue. White is a composite of the three primaries, and black is the absence of all color. Almost any other color can be produced by mixing the primaries in different concentrations.

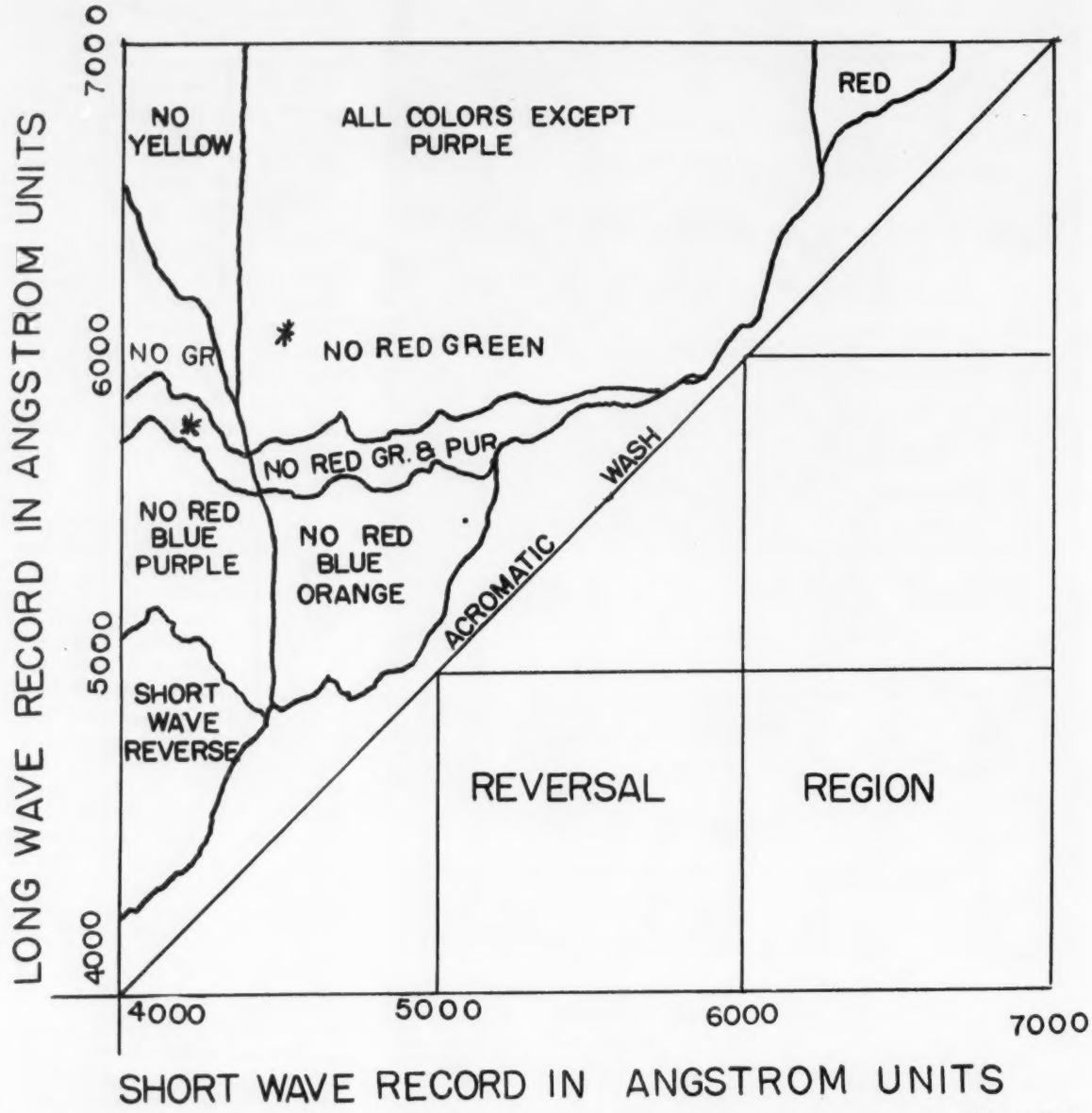
Color Photography

Full-color pictures can be reproduced by making three black and white photographs of the same scene respectively through red, blue, and green filters. If these photographs are projected through the filters through which they were made, and are superimposed upon each other on a screen, a true, full-color reproduction of the original scene will be observed. In 1855, James Clerk Maxwell produced the first color photograph using this method. The principle is used today in more sophisticated form in modern color film. Three layers of emulsion are placed on the same strip of film, and each records one of the three primary colors.

In 1914, W. F. Fox and W. F. Hickey experimented with motion pictures in which alternate frames of black-and-white film were shot through a red filter and through no filter and then projected in the same way. The image seen contained a full gamut of color, contrary to the Young-Helmholtz theory. But the extra colors were attributed to eye fatigue or some trick of the eyes, and no further investigation was undertaken.

Land Experiments

Recently, a new theory of color vision was advanced by Dr. Edwin H. Land. By using apparatus similar to that used by Maxwell, he



Delia A. Corkey

Above is a map of the colors obtained with variously filtered long and short records. Along the ordinate are plotted the wavelengths of the long record, and along the abscissa are plotted the wavelengths of the short record. Given any two wavelengths for the filter colors, we can use the map to predict what colors will be present in the projected image. When the long record is projected with a shorter wavelength than the short record, the intersection point of the two wavelengths falls in the reversal region. Not much is known about this region yet excape that complements of color appear, even though they may not be the usual Newtonian complements.

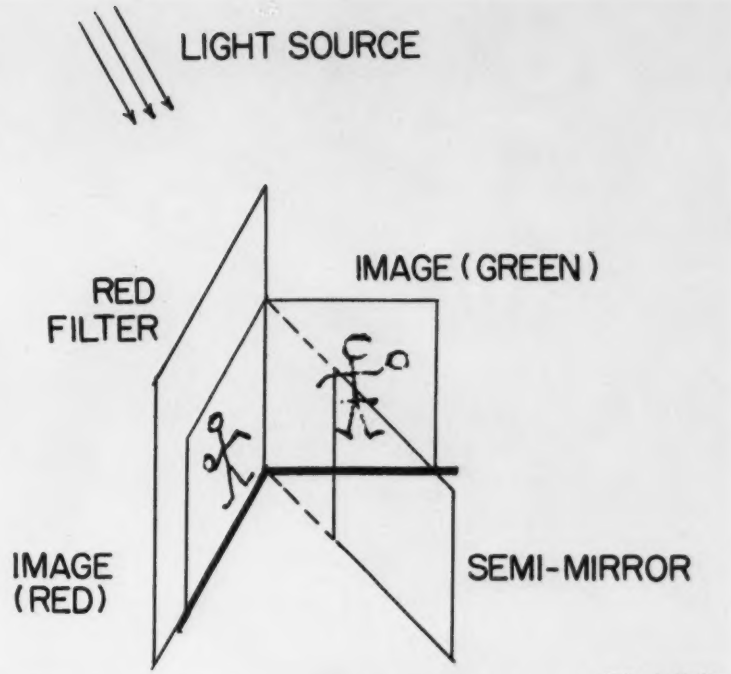
discovered that if the blue projector was turned off and the red and green left on, a full-color reproduction still remained. Land then entered upon an extensive series of experiments to determine what pairs of filters would give full-color pictures. He developed a camera in which the image is cast simultaneously on two different sheets of film. Any desired filters can be placed in front of the sheets to produce the two necessary pictures. The positive transparencies that are produced are projected in two beams of different monochromatic light, the beam of longer wavelength through the transparency taken with the longer wavelength filter. This picture is called the "long record." The other is the "short record."

Contrary to what might be expected, the colors of the original scene will be observed just as certainly even if the projection filter colors are not the same as those that were used when the picture was made. In general, the only requirement for success of the process is that the long record be projected with the light of longer wavelength. However, this rule does not hold in one small special area of the spectrum, in which the long and short records must be interchanged to produce the original colors.

The visible spectrum ranges from 4,000 to 7,000 angstrom units (A). Incredible as it may seem, in certain regions of the spectrum the long and short wave light sources need differ by only 100 A in order for the eye to perceive the full range of spectral colors in the projected picture.

Actually, bands rather than single wavelengths are passed by filters, though Dr. Land has used more sophisticated experimental equipment to produce bands of any desired width. He has discovered that the width of the bands is not of great importance. In fact, one of the two bands can be so wide as to include the entire visible spectrum. In other words, unfiltered white light can be used as one of the projector light sources. Dr. Land frequently uses red and white as the two projection colors.

If the projectors are turned on before the transparencies are inserted, the screen will of course appear pink. However, as soon as the appropriate transparencies are placed in the projectors, the observer sees not pink, but the entire range of spectral colors as they existed in the original scene. All that the transparencies do is introduce random variations in the relative intensities of red and white light striking the screen. Thus we see that the random point-to-point variation in the relative intensities of the two colors projected on the screen is all the information that the eye and mind need in order to perceive the entire visible spectrum.



Delia A. Corkey

This simple device provides a quick way of observing superimposed long and short records without using projectors. Clip the transparencies to a right-angle support, as shown, and place a red filter (e.g., cellophane) behind the long record. Place a semi-mirror at a 45° angle to the transparencies and juggle things around until the reflected image of one transparency falls on top of the image of the other transparency which can be seen directly through the semi-mirror. Varying the angle at which the whole system is held against the light source varies the relative brightness of the red and white images.

Randomness

Suppose the variations are not random. Suppose a neutral wedge filter is introduced into each projector to gradually reduce the intensities of the projected beams from full brightness to no light at all. If a wedge is inserted into the red projector horizontally and into the white projector vertically, and the beams are superimposed upon each other, a wide range of point-to-point variation in the relative intensities of the two colors will be produced. The variation, however, will be regular, and only the range of reds and pinks expected under classical color theory will be observed.

Thus we need the random variation that occurs in natural scenes if we are to see more than the colors predicted by classical color theory. This may explain why the phenomena observed by Land were not investigated earlier. Other color experimenters worked only with spots or patches of color and ignored natural color situations.

Instruments Used

These experiments have dealt so far with direct human perception of the projected pictures. What will instruments such as the camera and the spectroscope "see" when they look at the two-color projections?

When the screen is photographed with color film, the eye will see in the finished picture the same gamut of colors that it perceived on the screen. But if a spectroscope

Benson J. Simon

This is a reproduction of the first pair of color transparencies that author Simon made to test the two-color system. Red cellophane served as the long-wave filter (upper picture), blue as the short. Crude as this test was, startling results were obtained. We would hardly claim to have achieved true color in the projected image, but strong blues, weak yellows, shades of orange and some green, and, of course, shades of red were visible when the transparencies were projected in superposition with red and white light.

is focused on the original red and white projection or the color film copy, the only colors that the spectroscopist will report are pinks.

A fully colored photograph cannot always be obtained, however. Color film is particularly sensitive to red and white, and can record colors very accurately in this region of the spectrum. But it is not sufficiently sensitive to other areas of the spectrum to yield good reproductions with projection colors other than red and white.

Within a wide range, the colors in the projected picture are independent of the intensities of the two beams. If, for example, two copies of the long record instead of one are placed in the carriage of one projector, no change in the colors of the picture will be perceived, even though the intensity of the projected beam is decreased in proportion to the square of the transmission of the original transparency at every point. This systematic alteration in intensity is somehow ignored by the eye.

Uses

The application of Dr. Land's "bichromatic" system would simplify all reproduction processes which now utilize the three-color additive system. For example, color television now requires separate beams for each of the primary colors. A process utilizing Land's discoveries would require only two beams, one producing the black-and-white picture, and the other providing all the coloring information needed. This system also would eliminate much of the extremely delicate balancing of hues and brightness needed with the present process. Color photography also would be revolutionized by a change from a three-color to a two-color process. Although it appears now that two-color reproductions will not be quite as faithful as those possible with three-color systems, the quality may well be adequate for many commercial purposes.

Dr. Land's techniques apparently have not yet been perfected. Much work probably has to be done on the basic processes before any commercial applications can be attempted. Whatever the ultimate results of his work may be, Dr. Land has succeeded in shaking up the long-settled convictions of color theorists.

Some of France's greatest engineers are alumni of . . .

THE FRENCH POLYTECHNICAL SCHOOL

by Jeremy Shapiro, ME '61

"Pour la Patrie, les Sciences, et la Gloire"—this motto describes well the aim of France's *L'Ecole Polytechnique* (the Polytechnical School).

From its founding at the time of the French Revolution, *L'Ecole* has been reknowned throughout Europe for its brilliant engineering students, many of whom have become great civil servants of France. Its scientific tradition, beginning with LaGrange, LaPlace, Ampere, and Fourrier, all among its founders and first teachers, continues now as strong as ever.

French Education Different

The French system of education is generally representative of the European one, and is completely different from our own. Before a French student can follow a course of higher study on the university level, he must pass his *baccalauréat*, an examination that comes at the end of his secondary school education. This exam is a highly comprehensive one, covering many subjects. The student is required to pass every section.

For many students, this obstacle is the hardest one to overcome during the course of their education, and after reaching the university level, life becomes substantially easier. However, for the young student training to become an engineer, this is not the case; and the process by which he eventually gains his college degree is a difficult one.

Just before his last year in secondary school, the prospective engineering student must elect to follow a course of study leading to a career in science. This involves a program of mathematics, science, and a modern language, and he is examined for his *baccalauréat* in these subjects as well as those which preceded the last year.

Then, after having passed the *"bac,"* the student must take even more specialized courses dealing mostly with mathematics, usually for two years. He is given a thorough introduction to many topics, including vector analysis, linear algebra, calculus, and differential equations. He also takes physics and chemistry courses roughly equivalent to the introductory courses in the same subjects for American engineering students.

The courses given in the two preparatory years are standardized in order that schools throughout France can prepare their students on an equal basis for *les concours,"* the competitive entrance examinations to *L'Ecole Polytechnique*. It is during this time that the students become acutely aware of the tremendous competition for admission. Of 3,000 students enrolled in the special courses, 1,500 to 1,800 take *"les concours,"* and only 300 are accepted into *L'Ecole Polytechnique*. The others may try again, or enroll in other schools of poorer caliber.

Les Concours

"Les concours" are open to all qualified students between the ages of seventeen and twenty-one, and they may only be taken twice. First, the candidate takes a series of written exams in mathematics, physics, chemistry, graphical design, and a modern language. He then takes oral exams, which are given much greater weight, in the same subjects excluding the graphical design. The examiners feel that on a written exam a candidate can appear to know more than he actually does, but that during an hour's interrogation, he must show the real extent of his knowledge. Finally, he takes part in several physical trials which are given only a very small weight.

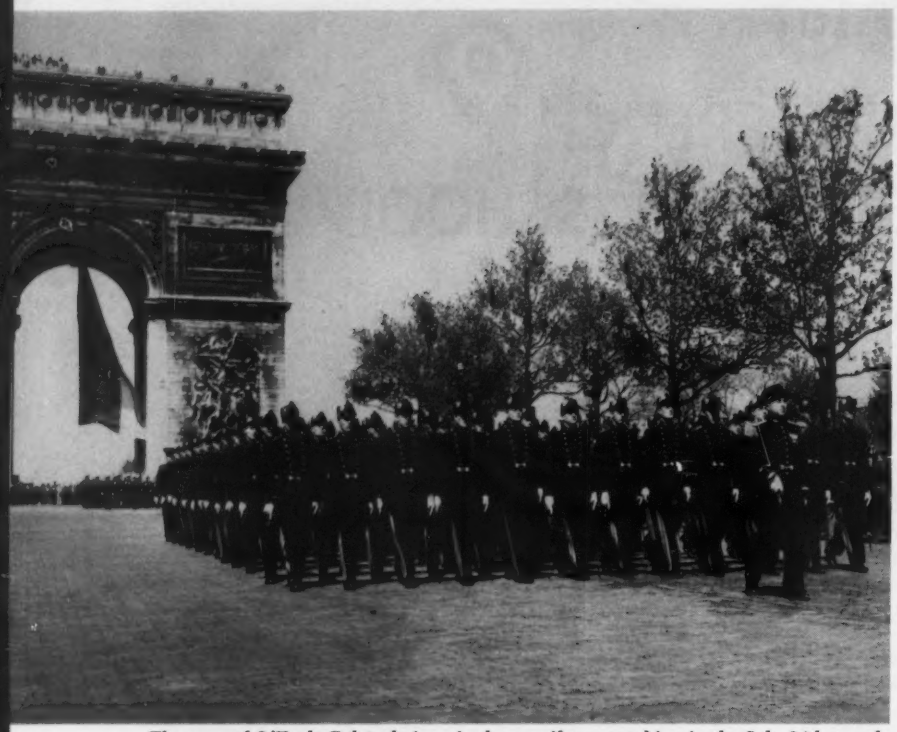
Military Regime Promotes Camaraderie

Once accepted into *"L'X"* (the nickname of *L'Ecole Polytechnique*), a young man has two very hard years before him. The school is conducted under military regime, with every student obliged to wear a uniform at all times and to follow the rules of military etiquette. In addition to a huge academic work-load, there is a two hour drill every week, five hours of compulsory sports, three weeks at summer camp, and a two week individual outing in the country.

A student is not allowed to leave the school except for Wednesday evening, and from noon Saturday to Sunday evening, although "a few hours are frequently authorized also during the afternoon."[1] Of course there are vacations of a week or two at Christmas time and in February, and a longer period during the summer.

L'Ecole tries to promote a feeling of *camaraderie* among its students, which undoubtedly must exist because of the closeness in which they live and the academic pressure to which they are subjected. There are twelve students in a room, which has facilities for both sleeping and studying. One also finds within the walls a library, game room, radio studio, record room, and photo studio.

The confinement, the military atmosphere, and the resulting *camaraderie* give the *polytechnicien* a clear view of his academic responsibilities and the goals towards which he is working. This is an atmosphere completely unlike that



The men of L'Ecole Polytechnique in dress uniform marching in the July 14th parade along Les Champs Elysees with L'Arc de Triomphe in the background.

which exists in most of our engineering schools. Under our system, one can easily become lost in any number of miscellaneous activities, and "bust-out" anonymously at the end of the year, or, what is worse, graduate knowing comparatively little about engineering. Of course, our economy demands a much greater number of new engineers each year, and consequently our schools could not afford to be as rigid in their standards, but this is only a partial excuse.

Naturally, the answer to this fault in our more *laissez-faire* type of system is that we want to produce more than just intelligent, functioning machines, but creative, thinking human beings. It is true, also, that the *polytechniciens* do have an odious reputation in France of being too logical, too scientific, and of seeing everything in either "black or white." All in all, neither system appears to have the perfect solution.

Instruction and Course of Study

L'Ecole is commanded by a general, but the academic studies are under the control of the Director of Studies, and the academic courses are not necessarily given by military men. The underlying principle of instruction is that the *polytechnicien* "learns how to learn" and is not subjected to a course of study considered to be too long or too full.

This last consideration must be taken from the faculty's point of view and not that of the student, because the course of study is very hard, and it is doubtful that any *polytechnicien* considers his task neither too long nor too full. During the two years of study, he takes a full schedule of mathematics and science, including astrophysics; a modern language; economics; introductions to history, literature, and architecture; and a general study of art.

L'Ecole emphasizes the fact that its students follow non-scientific courses, ones designed to develop "their general culture," [2] and it may be said that the young men from "*L'X*" today are more broad in at least their formal education than their infamous predecessors. There are no courses taught in specialized fields of engineering and this education must be gained in an *Ecole d'Application* after graduation.

The courses themselves are divided into *"les amphis,"* which are large lectures of three hundred students where the professor explains fundamental points, and *"les petites classes"* of twenty-five students where the work is augmented with written exercises. The texts of the course are printed and distributed to the students in advance so that they can prepare adequately before all classes. There is practical laboratory work in mechanics, physics, and chemistry.

At the end of each semester there are final examinations given by a selected group of faculty members called *"les examinateurs."* These men examine not only the students, but also the courses themselves, to discover where improvements could be made. The students are ranked by the grades they receive on the final exams and other grades received during the semester. It is this class standing that determines which students will have first choice of the various military and civil assignments offered when they graduate.

Careers After Graduation

Upon graduation, all the *polytechniciens* become commissioned officers, and must serve at least one year in active service. Some receive permanent career assignments in the Engineering Corps, although many take non-military positions after their year of active service.

In any case, a graduate must stay in the service of the state for ten years in order to repay the government for his free education. However, there is provision for him to demission after graduation if he reimburses the state for the cost incurred. There is also provision made for a very small number of foreign students to attend *L'Ecole* without serving the French government afterwards.

The graduates entering the Engineering Corps must go to a *Ecole d'Application* for two years where they receive instruction in a specialized field, such as land defenses. This specialized training is intended to give the *polytechnicien* a practical vocation which makes it easy for him to find work after his early retirement from the armed services. Fewer graduates have been choosing this field in recent years.

Another possible career is in *"Les Grandes Corps Techniques"* (Great Technical Corps), which comprises all the bureaus of administration that regulate French private industry and manage all public industry. A number enter this field and then retire from the service after ten to twenty years, when they have made a sufficient number of contacts to find good situations in private industry. However, by the age of fifty, half of *"Les X's"* have become Engineers of the State, both civil and military.

For the students who demission after graduation, it is necessary to enter an *Ecole d'Application.* In the traditional fields, such as mines, bridges, and sea-walls, the course of study is two years long; while in the newer fields, such as petrol or textiles, it lasts only one year. Almost all who demission enter large industries instead of small businesses.

In addition, some graduates of *L'Ecole* find careers in research, architecture, politics, and a hundred other fields. Examples of these are Comte, the famous French philosopher, Foch, the general in charge of allied forces during World War One, Carnot, Fresnell, Gay-Lussac, Citroen, and many other famous personages.

The French take pride above all in the great men their culture has produced. Every other street in Paris is named after a hero, and the city is cluttered with statues of famous men and women. In the home, the Frenchman covers his walls with pictures of Napoleon, De Gaulle, Hugo, and many others. And so *L'Ecole Polytechnique* is a typically French institution as it tries to maintain its high standard of education, one capable of making great engineers and men of the boys with undeveloped abilities who enter there.

Footnotes

[1] Quoted from information given the author by *L'Ecole* that will soon be part of an official brochure.

[2] Ibid.

Engineering students crowding the streets upon leaving a technical school in Paris.

The George W. Rogers Construction Company builds and maintains . . .

STRUCTURES FOR A GROWING PORT

by Mary Ann Huber, CE '63

The Port of New York's 300 miles of improved waterfront represent a year-round challenge in construction and maintenance work. Headed by a Cornell alumnus, George W. Rogers, C.E. '20, the George W. Rogers Construction Company has been meeting this challenge for the past ninety years. Since its founding in 1869, the company has specialized in waterfront construction "from mudline to masthead."

Waterfront construction and maintenance involves working with a wide variety of structures. Construction tackled by the Rogers Company includes marinas, piers, bulkheads, industrial plants and warehouses, and pier sheds. The maintenance and repair of existing facilities provides added opportunities for waterfront specialists. A port handling over 150 million tons of cargo per year receives an enormous amount of wear and tear!

Pier Construction

Within the past two years, the Rogers Company has completed the substructures of two of the longest finger piers in New York Harbor, one of them possibly the longest in the world. This pier, 1,740 ft in length, was built as part of New York's five-year waterfront improvement program, to replace a pier destroyed by fire in 1956. Miles of both new and reused piling formed the substructure, which was then topped with a huge concrete deck. The pier shed and work area were redesigned for greater efficiency in cargo handling. Stevedoring and trucking operations have been separated by the use of a trucking lane outside the pier shed, permitting longshoremen to transfer cargo easily and swiftly from ship to truck. The pier can service three large cargo ships simultaneously, as well as a number of cargo lighters and barges.

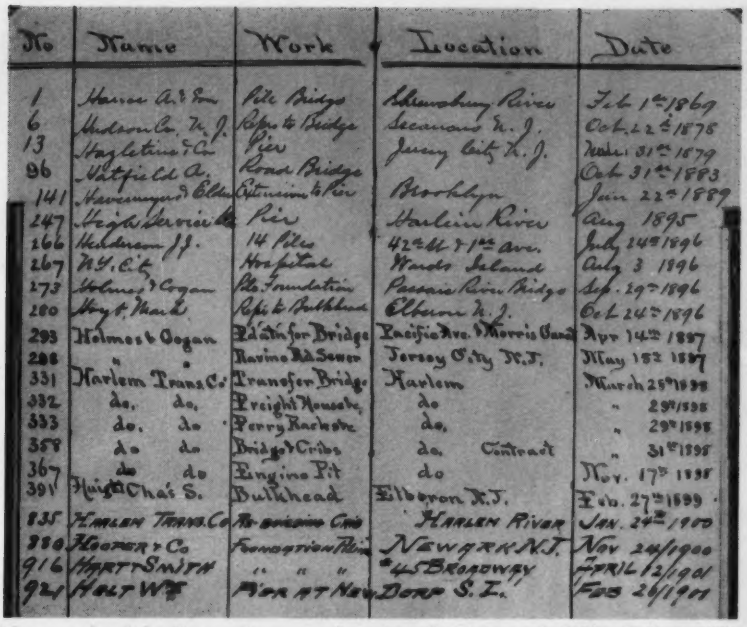
The second pier, 1,400 ft long, can serve as many as four large vessels at a time. The building of this facility presented considerable difficulties, since the concreting of the deck was in progress during the severe winter of 1958–59. However, by keeping careful check on the temperature, and by use of quick-setting cement and fiberglass insulation, the job was completed successfully.

George W. Rogers '20, heads the George W. Rogers Construction Company, which specializes in the building of piers, bulkheads, marinas, and other waterfront facilities.

Maintenance on the waterfront is a never-ending struggle to repair damage caused by the elements and human error. Rot and corrosion take their toll of wooden and metal structures, and corroding parts must be replaced. Impact from the docking of vessels and from floating debris also contributes to the problem of keeping the waterfront ship-shape. However, there is surprisingly little damage caused by marine organisms, since the pollution of the harbor has eliminated many of the usually destructive species. In the winter months, ice poses a threat to piers in the harbor, particularly those on the western shore. The form of the river channel and the prevailing wind tend to push the ice toward New Jersey, where it is ground against pier substructures by the docking ships. Occasionally the ships themselves may ram the piers, and serious damage may result.

Fenders Prevent Damage

Under their late Chief Engineer, Edward G. Carey, the Rogers Company pioneered in the construction of wood and rubber "fenders" to help prevent damage to docking ships. The present form of the fender was originally developed for the S.S. United States. It consists of two rows of high-tensile rubber tubing, one vertical, the



No	Name	Work	Location	Date
1	Haines A. & Son	Pile Bridge	Shrewsbury River	Feb 1st 1869
6	Hudson Co. N. J.	Repairs to Bridge	Secaucus N. J.	Oct 22d 1875
13	Hazletine & Co	Pier	Jersey City N. J.	Nov. 31st 1879
96	Whitfield A.	Road Bridge		Oct 31st 1883
141	Havemeyer & Elder	Extension to Pier	Brooklyn	Jan 22d 1889
247	Wright Service Co	Pier	Harlem River	Aug 1895
266	Hudson J.	14 Piles	42d St & 1st ave.	July 24th 1896
267	N.Y.C.R.R.	Hospital	Wards Island	July 3 1896
273	Holmes & Logan	Pile Foundation	Passaic River Bridge	Sept. 29th 1896
280	Hoyt & Hawk	Repairs to Bulkhead	Elborn N. J.	Oct 24th 1896
293	Holmes & Logan	Addition for Bridge	Pacific Ave. & Morris Canal	Apr 14th 1897
298	" "	Ravine Rd Sewer	Jersey City N.J.	May 15th 1897
331	Harlem Trans Co	Transfer Bridge	Harlem	March 25th 1898
332	do. do.	Freight House &c	do	" 29th 1898
333	do. do.	Ferry Racks &c	do.	" 29th 1898
358	do do	Bridge & Cribs	do. Contract	" 31st 1898
367	do do	Engine Pit	do	Nov. 17th 1898
391	Haight Chas S.	Bulkhead	Elborn N.J.	Feb. 27th 1899
835	Harlem Trans Co	Re-erecting Crib	Harlem River	Jan. 24th 1900
880	Hooper & Co	Foundation Piers	Newyork N.Y.	Nov 24th 1900
916	Hart & Smith	" " "	45 Broadway	April 12th 1901
924	Halt W.T.	Work at New	Dorp S. I.	Feb 26th 1901

The records of the Rogers Company show their first job, a pile bridge built in 1869.

other horizontal, hung against the existing piling at the corner of the dock. Outside of the tubing, oak sheathing supported by piles absorbs the impact of the ship and transmits it evenly to the rubber.

The use of such corners greatly speeds the docking operation. With the liner resting against the pier corner, it is possible for tugs to use this corner as a fulcrum, and so to push the vessel into proper docking position. If no tugs are available, the liner itself can make use of this aid to dock under its own power. An attempt of this sort on an unprotected pier would be extremely hazardous. These fenders also make it safe to dock without waiting for slack tides, saving considerable time, money, and annoyance on the part of impatient passengers. They have been installed on many of the major luxury-liner piers in the harbor, as well as on berths designed for freighters and oil tankers.

In recent years, the Rogers Company has added a variety of structures to New York's waterfront scene. In 1952, the company announced the opening of a new service devoted to the building of pier superstructures, from roofing through painting and electrical work. One of the company's major projects was the construction of one-quarter of a mile of bulkhead along the Harlem River. Part of this bulkhead extends along the route of the proposed Second Avenue subway, and was topped with macadam paving with a view to possible roadway construction. In addition to waterfront construction work, the company installs fire sprinkler systems in industrial buildings, offices, and warehouses. Pipelines, tank foundations, and railroad sidings for oil terminals have also been constructed by the Rogers Company.

Long History

The company's long history of waterfront construction know-how started with its founding by the grandfather of the present Mr. Rogers. The first order, placed in 1869, called for the construction of a pile bridge over the Shrewsbury River in New Jersey. Among the early jobs were other bridges, pilings, and a hospital on Ward's Island.

Although the Rogers Company does not claim to be the largest in its field, its present facilities are up-to-date and capable of tackling the most demanding jobs on today's waterfront. The floating equipment includes two huge whirley cranes, pile drivers, and derrick boats. Land equipment consists of crawler cranes, concrete mixers, and compressors. The company maintains a marina on Staten Island, a machine shop, blacksmith shop, and carpenter shop.

The new redevelopment program for New York's waterfront, expected to cost $200 million, will have a great impact on the waterfront construction industry in the next few years. Its completion will give the city unparalleled port facilities and reaffirm its place as the world's greatest center of waterfront commerce.

Two machines put finishing touches on the fender system for the 1400-foot pier recently completed in Brooklyn.

...THE EXPLORATION OF SPACE

Since its inception nearly 23 years ago, the Jet Propulsion Laboratory has given the free world its first tactical guided missile system, its first earth satellite, and its first lunar probe.

In the future, under the direction of the National Aeronautics and Space Administration, pioneering on the space frontier will advance at an accelerated rate.

The preliminary instrument explorations that have already been made only seem to define how much there is yet to be learned. During the next few years, payloads will become larger, trajectories will become more precise, and distances covered will become greater. Inspections will be made of the moon and the planets and of the vast distances of interplanetary space; hard and soft landings will be made in preparation for the time when man at last sets foot on new worlds.

In this program, the task of JPL is to gather new information for a better understanding of the World and Universe.

"We do these things because of the unquenchable curiosity of Man. The scientist is continually asking himself questions and then setting out to find the answers. In the course of getting these answers, he has provided practical benefits to man that have sometimes surprised even the scientist.

"Who can tell what we will find when we get to the planets? Who, at this present time, can predict what potential benefits to man exist in this enterprise? No one can say with any accuracy what we will find as we fly farther away from the earth, first with instruments, then with man. It seems to me that we are obligated to do these things, as human beings."

DR. W. H. PICKERING, Director, JPL

jpl

CALIFORNIA INSTITUTE OF TECHNOLOGY

JET PROPULSION LABORATORY

A Research Facility operated for the National Aeronautics and Space Administration

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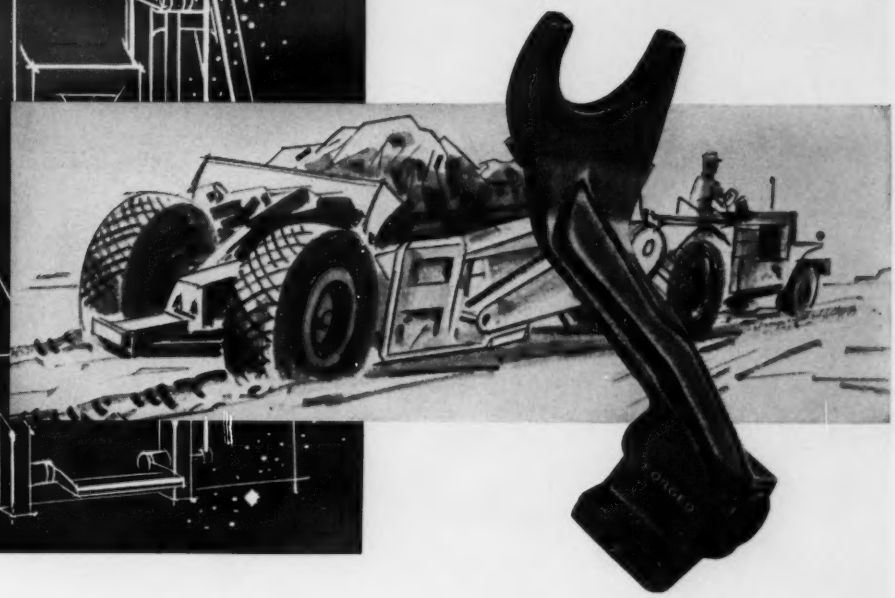

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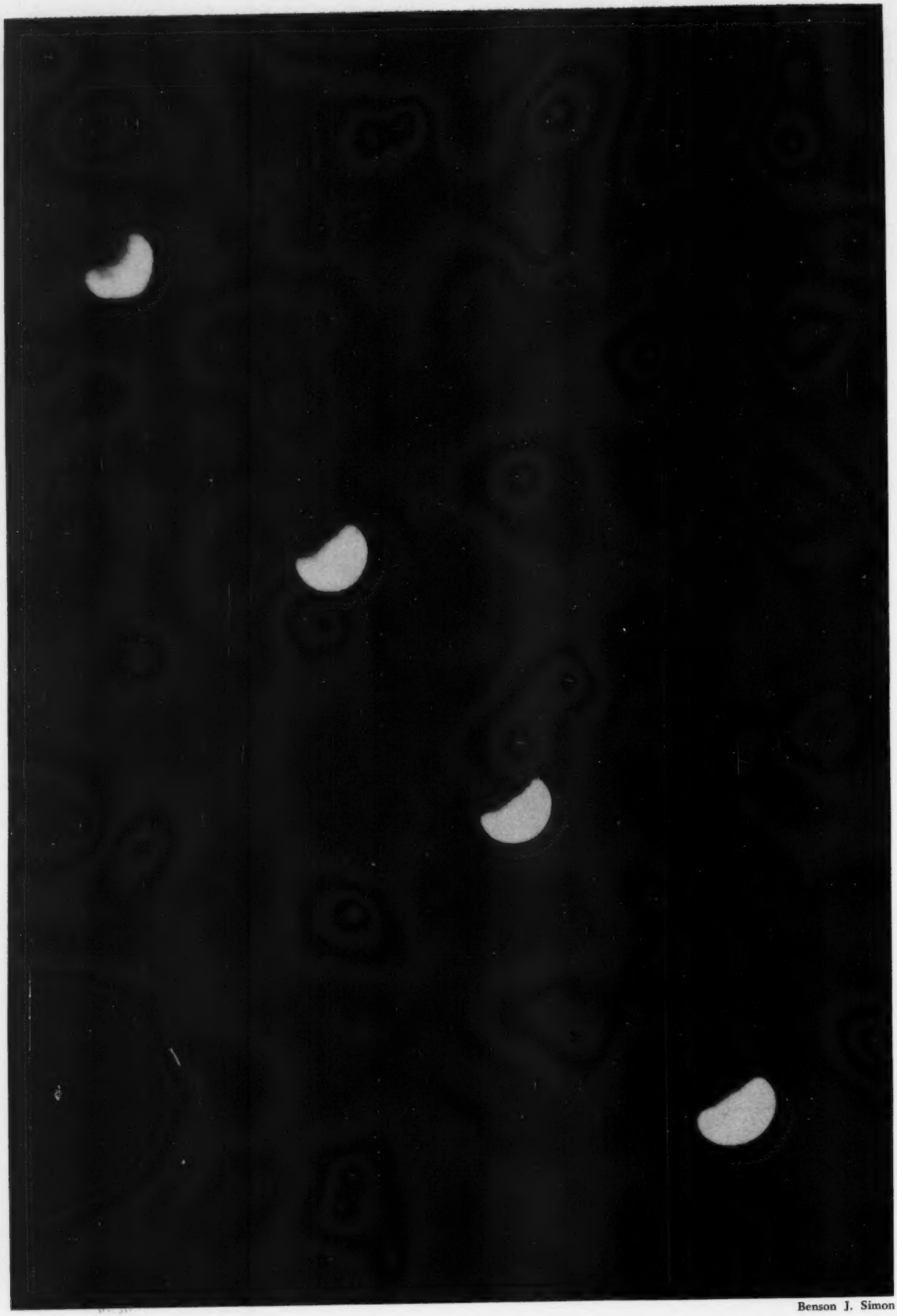


Benson J. Simon

LUNAR ECLIPSE PHOTOGRAPHED BY THE *ENGINEER*

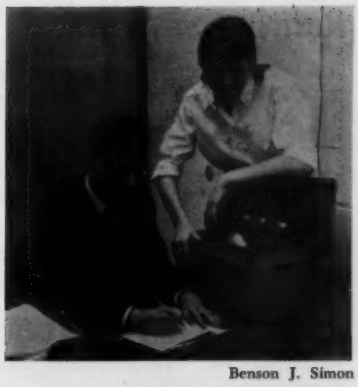
A total eclipse of the moon, visible at times over cloud-shrouded Ithaca, occurred on March 13. Using a variety of equipment in the subfreezing weather, we managed to obtain several pictures of its early phases.

Picture on the opposite page was made with a Crown Graphic on a sheet of 4x5 Professional Ektachrome, ASA 32. Fuzziness of the image is the result of thin clouds passing in front of the moon. The shutter was opened four times in succession to record the four images shown. Plan was to expose at ten-minute intervals, making successively longer exposures as the moon proceeded deeper into the earth's shadow. Ultimately, intervals were governed by the time at which breaks occurred in the heavy clouds.

Exposure "guesstimates" were extrapolations of published photographic data for previous lunar eclipses. Sequence begins at the upper left of the page and proceeds downward. Obscuring clouds prevented further exposures, but the characteristic coppery-red color of the shadow was visible for an instant just after the beginning of totality.

All exposures were made at f/4.7. The first was taken at 1:42 A.M., EST, four minutes after the moon entered the umbra. Exposure time was 1/30 of a second; temperature was a mighty chilly 26F. Second exposure, at 1:52 A.M., was for 1/20 of a second. Third, taken at 2:12 A.M., was for 1/2 second. By this time the temperature had fallen to 22F. Final exposure of one second was made at 2:27 A.M., fourteen minutes before the moon was supposed to pass completely into the earth's shadow.

Next total lunar eclipse visible in this area will occur on September 5, 1960.—B. J. Simon

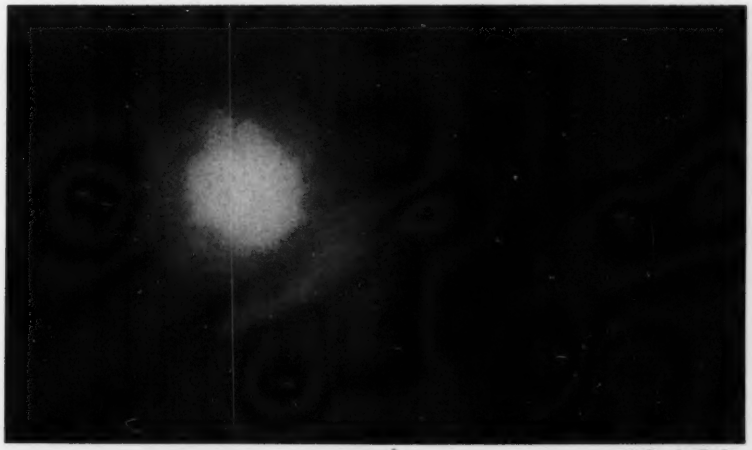


Benson J. Simon

Photographers Simon and Corkey check out camera equipment and plan the expedition. Benson, ex-Feature Editor of the ENGINEER, is one of the fifth year men who retired from the Publication Board in April.

Benson J. Simon

"Shall we use Ektachrome or Tri-X?" wonders Delia Corkey. Delia, a freshman EP, has become one of the staff's most active photographers.



Delia A. Corkey

This picture, taken when the moon was deep in the penumbra, reveals the cloud conditions the night of the eclipse. The picture was taken with a Fujica on 35 mm High Speed Ektachrome, ASA 160. Exposure time was one second at f/2.8.

Delia A. Corkey

Photographer, kneeling, uses flashlight to check exposure data. Interested observer, one of many who stopped for a look, is Ronald Walter, a freshman at MIT. Light snow was falling when this picture was taken.

Retiring Staff . . .

Several members of the staff of the CORNELL ENGINEER are retiring this term as their graduation approaches. For their gracious service to this publication and to the University, the ENGINEER takes pride in introducing them to the readers.

Alan S. Rosenthal, a graduating EE from Millburn, New Jersey, is the retiring Editor of the ENGINEER. He joined the staff five years ago as an Editorial Board member and served as Assistant and Assistant Managing Editor. Alan's editorial experience includes more than eight years of professional as well as non-professional work. As a member of the Publication Board of the magazine, he wrote the present style sheet and was instrumental in the organization of the editorial training program. During the past year he has tried to revise the magazine's editorial policies and has used his editorials to spotlight different problems in engineering education.

Alan's other campus activities include membership in the Engineering Student Council, WVBR, and the Delta Club. He has also worked with the Campus Conference on Religion and the Cornell Dramatics Club. He is a member of the Student branch of the AIEE-IRE and Pi Delta Epsilon, the journalism honorary. Alan has completed the advanced Army ROTC program and will be commissioned in June. He expects to spend six months in the Signal Corps.

David Lamensdorf joined the ENGINEER as a freshman and worked his way up through the Editorial Board to the position of Associate Editor and subsequently Managing Editor. David, who comes from South Hempstead, New York, is enrolled in the School of Electrical Engineering. At present he holds a position as an instructor in an electronics course. He has participated in the engineering cooperative program with General Electric Corporation. This summer he plans to go to Copenhagen, Denmark as part of a program for technical students. After working there for eight weeks, he will spend the remainder of the summer touring Europe before coming home to do graduate study in electrical engineering. David is a member of Eta Kappa Nu, the electrical engineering honorary. He is also a member of Pi Delta Epsilon.

Chester R. Fox, a student of the School of Chemical Engineering, has served the ENGINEER as Advertising Manager, Treasurer, and Business Manager. As treasurer, he introduced major improvements into the Corporation's accounting system. During the past year, he has been actively engaged in a program to revise the magazine's corporate status. Chester is a member of Tau Beta Pi, the engineering honorary, and Vice-President of Pi Delta Epsilon. His interest in business activities extends to the student chapter of the AIChemE, of which he was Treasurer. He has worked on the Engineers Day program and belonged to the Cornell Rifle and Pistol Club. Chet's high scholastic performance has qualified him to tutor freshmen in calculus and teach mathematics 162. He is now an instructor in the Unit Operations Laboratory. Having completed the Army ROTC program, he will be commissioned a Second Lieutenant in the Chemical Corps. When his six-month obligation is completed, he will seek a job in the chemical process industry. Chet is from Flushing, New York.

Benson J. Simon, a former electrical engineering student, is an economics major in the College of Arts and Sciences. Last year he was asked to assume the position of Feature Editor of the ENGINEER. Prior to this he had run the editorial training program. Benson is a member of WVBR and has been on crew. He has had commercial writing experience in summer work for the McGraw-Hill Publishing Company. Next year he will begin working for a Masters Degree in business administration. Benson is a resident of New York City.

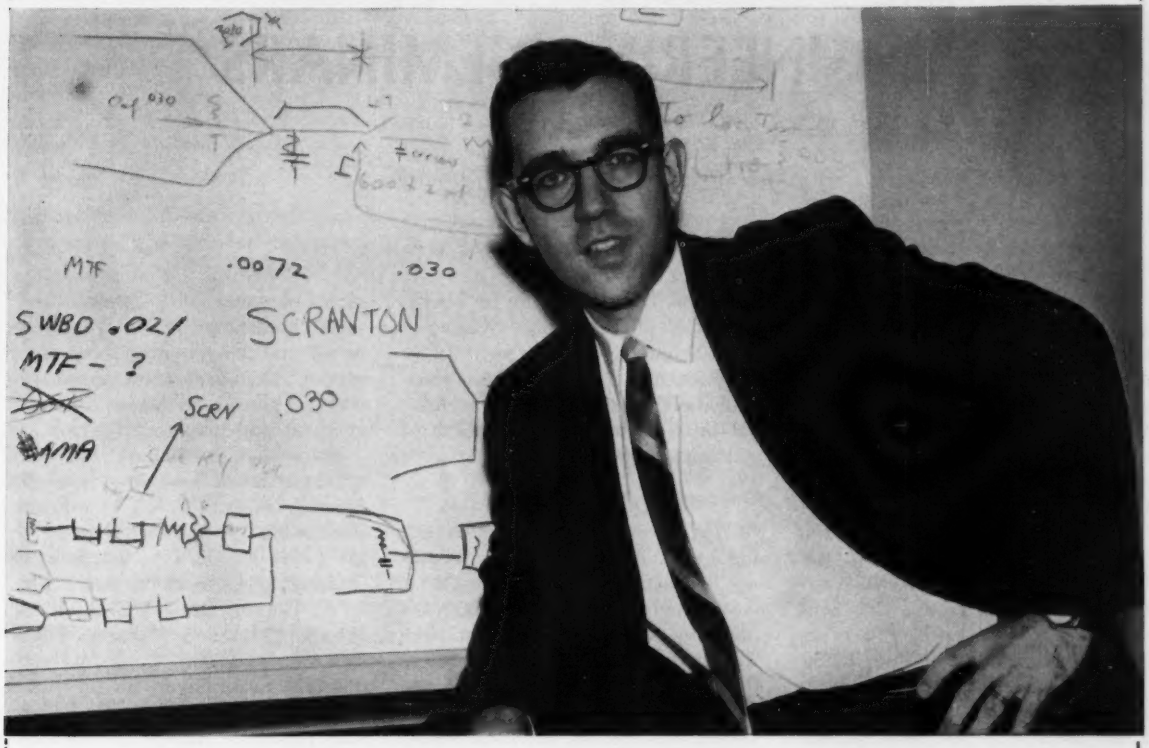
Robert J. Loane, of Reading, Pennsylvania, began working for the ENGINEER four years ago as a compet for the business department. Since then he has served with the circulation department, become Circulation Manager, and taken the job of Treasurer. Robert is an instructor in the course of electrical machinery for non-electrical engineers. He is an EE and belongs to Eta Kappa Nu. Robert has completed the Navy ROTC program. His post-graduate plans include a two-year tour of duty in the Navy.

Erik Gregersen, a student in the School of Mechanical Engineering, worked five years on the Illustrations Board as a photographer. He is a member of Delta Chi social fraternity and has served on the Undergraduate Secondary Schools Committee. After graduation, Erik will seek work in industrial engineering.

Norman Brockmeier has been a member of the Illustrations Board since his freshman year. Upon graduating from the School of Chemical Engineering, Norm will work for a large chemical company. Norm is a member of the Cornell Amateur Radio Club, the Men's Glee Club and Seal and Serpent Fraternity, of which he was vice-president.

Seated, left to right: Chester Fox, Norman Brockmeier, Alan Rosenthal, Robert Loane, David Lamensdorf. Standing: Benson Simon, Erik Gregersen.

A Campus-to-Career Case History



"I found I could be an engineer —and a businessman, too"

William M. Stiffler majored in mechanical engineering at Penn State University—but he also liked economics. "I wanted to apply engineering *and* economics in business," he says, "and have administrative responsibility."

Bill got his B.S. degree in June, 1956, and went to work with the Bell Telephone Company of Pennsylvania at Harrisburg. During his first two years, he gained on-the-job experience in all departments of the company. Since June, 1958, he's been working on transmission engineering projects.

Today, Bill is getting the blend of engineering and practical business-engineering he wanted. "The economic aspects of each project are just as important as the technical aspects," he says. "The greatest challenge lies in finding the best solution to each problem in terms of costs, present and future needs, and new technological developments.

"Another thing I like is that I get full job-responsibility. For example, I recently completed plans for carrier systems between Scranton and four other communities which will bring Direct Distance Dialing to customers there. The transmission phase of the project cost almost a half-million dollars and was 'my baby' from terminal to terminal.

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THE CORNELL INDUSTRIAL ENGINEERING SEMINARS

by Prof. John M. Allderige

For the past six years, the Cornell Industrial Engineering Seminars have been offered in June directly after graduation exercises and the associated alumni activities. The 1960 Seminar is the seventh edition of an event that has now become an annual fixture on Campus. This year, from June 14 through 17, approximately 150 engineers and managers from the United States and Canada will participate in small groups that will probe, in some depth, the ever-growing body of techniques being developed for handling industrial problems. The Seminars are sponsored by the Department of Industrial and Engineering Administration in the Sibley School of Mechanical Engineering.

Management Science

Despite the popularity of computers and their work on industrial problems, it is still generally thought that Industrial Engineering is "soft" engineering reflecting little, if any, "hard" scientific development such as the physical engineering disciplines employ. The past several years, however, have seen the emergence of "hard" Management Science. Operating under various labels such as "Operations Research" and "Management Science," men of science are bringing keener insight to engineering and management problems. Mathematics frequently working through electronic computers, now resolves many old headaches of production control, inventory control, and budgeting and, in so doing, works toward decreased costs and increased profits. Business system models can be set up, the effect of alternative plans predicted, and the plans evaluated. This tends to release management's judgment for the vital human problems so often pushed aside. Management Science is thereby paving the way for new personal dimensions in leadership as it develops technical innovations for Industrial Engineering applications.

The Seminar Program

There are seven seminars covering a wide range of subjects. These are detailed below. There are several events of common interest, however, that are worth noting. The keynote address sets the pace for all the seminars – "Metamorphosis in Management" by Mr. David S. Greenlaw, Assistant Technical Advisor to the Kodak Park Manager, Eastman Kodak Company. And at the luncheon meeting of the first day, Dr. J. L. Zwingle, PhD. '42, Vice-President of the University, will give a welcoming address. Mr. Thomas Ware, B.S.-A.E.M. '40, President of the International and Minerals Corporation, will speak at the Banquet to be held on Wednesday, June 15. His topic will be "Management Problems and Opportunities." The closing luncheon on Friday will have Dr. A. E. Kahn as a speaker. He is head of the Economics Department at Cornell and will peer into the future with "Economic Predictions for the Sixties."

Seminar Group A—Industrial Management

This group will be directed by Professor Byron W. Saunders. It is a seminar series planned for management personnel in line and staff positions who are interested in the broad problems of industrial management, particularly those of the larger company. Past participants in the group held titles of president, treasurer, controller, plant manager, etc. Topics have been chosen for their vital interest to all operating management personnel. This year some emphasis will be placed on materials management and inventory control.

Several Cornellians will be speaking in this Seminar—Mr. G. B. Howell, BS.-A.E.M. '42, Vice-President in charge of Manufacturing of the Leece-Neville Co., will talk on "Managing Cost Reduction"; Mr. I. W. Hamm, '32, MME '33 Vice-President, Bonded Abrasives Division, Carborundum Company, will discuss "Equipment Policy and Capital Budgets"; Dr. R. E. McGarrah, PhD '51, Associate Professor at the Harvard Business School will talk on "Materials Management"; and Mr. Alan Gast, B.M.E. '56, M.I.E. '58, currently Systems Analyst, Industrial Engineering Division, Procter and Gamble Company, will cover "Inventory Controlled Scheduling."

Seminar Group B—Engineering Administration

This group is directed by Professor Henry P. Goode. This seminar series has been organized for individuals who are responsible for the administration of engineering and applied research activities. Discussion will be concentrated in areas of most importance in organizing and controlling engineering projects and departments. Methods for making the most effective use of the time and abilities of engineers and other personnel in the applied research and engineering organizations will also be considered. In all seminar sessions group participation will be emphasized with time in clinic sessions being made available for the analysis and discussion of specific problems brought in by participants.

Mr. J. V. Ottobre, B.E.E. '49, Manager, Development Laboratory, Stavid Division of Lockheed Electronics Co., will discuss "Cost Control for the Project Manager." Mr. D. H. Moyer, Director, Office of Student Personnel, College of Engineering at Cornell, is going to speak on the subject of "Manpower Planning and the Growing Shortage of Engineers."

Seminar Group C—Operations Management of the Smaller Company

This group will be directed by Professor J. W. Gavett, PhD '56, MME '52. This seminar series will concentrate entirely on the practical and profitable use of modern management science in the smaller company and branch plant. Participants will learn usable techniques based on Operations Research that can effectively solve problems of production control, inventory control, sales and purchasing. Actual cases involving marginal costing, waiting line analyses, simulation, statistical sampling and the use of mathematical models will be discussed. Also, an opportunity will be made available to try out new ideas in a full-day business game. Registration will be limited to executives from firms employing 500 or less employees.

Seminar Group D—Work Measurement

This group will be directed by Professor Martin W. Sampson, B.S.-A.E.M. '39, M.S. Engr. '45. This seminar series has been planned for industrial engineers interested in analyzing and discussing recent innovations in work measurement techniques. Among these will be the application of sampling theory, queuing theory and other statistical methods. Emphasis in the sessions will be on evaluation and successful applications of these innovations.

Several companies are represented on the speakers list—General Electric Co., Eastman Kodak Company, Armstrong Cork Company, and Joy Manufacturing Company. Considering the applications problems in this phase of Industrial Engineering, this wide representation from industry strengthens the seminar considerably.

Seminar Group E—Systems Simulation Using Digital Computers

Group E will be directed by Professor Richard W. Conway, B.M.E. '53 Ph.D. '58. The use of simulated experimentation in the analysis and design of complex systems is one of the most promising applications of high-speed digital computers. This series of seminar sessions will explore this expanding field and consider problems in constructing the program, in using a simulator, and in analyzing results. The work of the sessions will include the actual use of a production shop simulator as well as the presentation of successful industrial examples.

Besides Professor Conway, two other Cornellians will be speaking and leading discussions: Mr. W. L. Maxwell, B.M.E. '56, currently a doctoral candidate at Cornell, will discuss the Cornell Production Simulator and Dr. Wallace E. Barnes, Ph.D. '49, General Electric Company will talk on "Manufacturing Systems Simulation in the General Electric Company."

Seminar Group F—Statistical Decision-Making

This group is directed by Professor Robert E. Bechhofer. This seminar series is designed for individuals who are engaged in research, experimentation, production, inspection, or acceptance sampling where attention is centered on problems of selecting or ranking process, methods, or categories according to various criteria of "goodness." It consists of thirteen integrated sessions in which new statistical procedures will be proposed for coping with such multi-decision problems. The methods to be proposed represent a fresh, rational approach to the solution of certain classical problems. Sufficient theory will be given to justify the use of the procedures, but considerable emphasis will be placed on the approach and the applications. All participants in this seminar should have had a one-year course (or the equivalent) in statistics as background in order to obtain maximum benefit from the seminar and to contribute to the discussions.

Seminar Group G—Statistical Reliability Analysis

Group G will be directed by Professor John H. K. Kao. This seminar series will consist of thirteen sessions with the first half devoted to the statistical theory of reliability. The second half will cover techniques and applications including an optional workshop on problems from participants. Of the latter sessions, two will cover the important aspects of system reliability, (a) redundancy in design and (b) maintenance in operation. The seminar group is intended for practicing reliability engineers and for manufacturing executives whose responsibilities are to maintain product reliability through destructive and environmental tests, marginal checking and failure analysis. Applicants are assumed to have a working knowledge of statistical methods or to have taken at least one course, at college level, in statistics and probability theory.

The 1960 Cornell Industrial Engineering Seminar offers a larger and more diversified program of subjects and speakers than any past seminar. It will afford management and technical personnel the opportunity to keep abreast in the latest scientific developments in Industrial Engineering.

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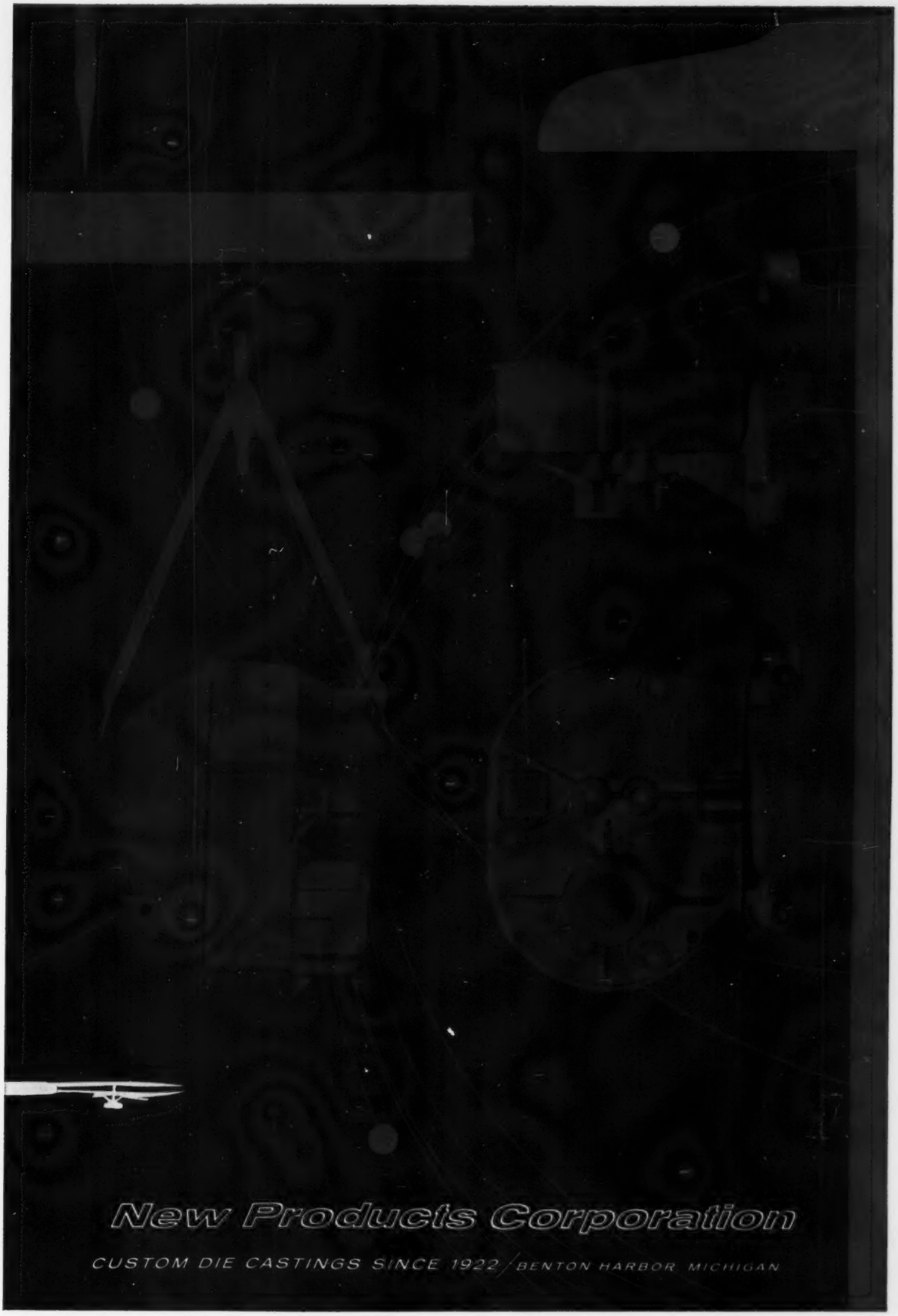

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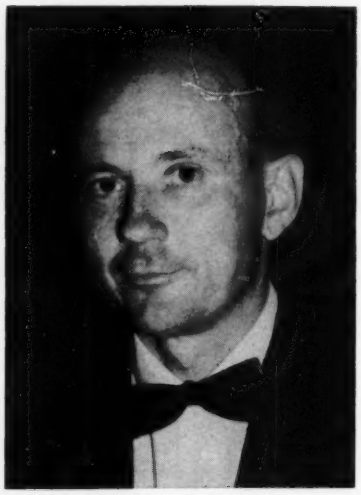

S. D. Teetor

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationship between the College and its alumni."

THE PRESIDENT'S LETTER—

TO THE FORTHCOMING GRADUATES:

Apathy, Greed, Avarice, Immorality, Materialism, Complacency—don't let even one of these adjectives be applied to your future professional activities. They represent "bugs" that cause a most deadly "disease" which is threatening America today. Instead of becoming victims, you can become the "doctors" to help eradicate this menace to our Democracy. Borrowing a paragraph from Louis Adamic, I quote . . . "there is a certain blend of Courage, Integrity, Character and Principle which has no satisfactory dictionary name but has been called different things at different times in different countries. Our American name for it is 'guts' . . .". The above quotation is from "A STUDY IN COURAGE", written in 1944.

Mr. Adamic's definition of what I think is needed today is a good one. And make no mistake about it, all the "guts" you possess will be needed to resist taking what might seem to be the easy way to success. In our materialistic society today many find it difficult to resist the so-called "fast buck". An Engineer is always subjected to great temptation, both technically and financially. In the course of the design of a project, whether it be a machine or a building, he may be tempted to give inferior engineering judgment in order to save money as far as his own design cost is concerned, and, in some cases, when out on construction projects, he will be approached by others and offered certain rewards if he is not too strict and does not insist on the Owner receiving his money's worth. These are but a few of the pitfalls that will be faced by a young engineer starting out in his profession, and even though at times you may see non-technical people receiving larger salaries, remember the professional accomplishments that you are making and the fact that the other man does not have the real sense of achievement that you will have. From time to time it will also be helpful to review the Code of Ethics of whatever branch of the profession that you may be practicing in.

STEPHEN D. TEETOR '43

ALUMNI ENGINEERS

Paul J. Wisniewski, Met.E. '52, has become the sales manager of the Wyman-Gordon Company's Prex plant in Franklin Park, Illinois. Since joining the firm in 1953, Wisniewski has worked as a metallurgist, foreman, and sales engineer.

William H. Jones, M.E. '26, vice-president in charge of purchasing and service operations of the Philadelphia Electric Company has been elected a director of the Delaware County National Bank.

Arthur W. Trouch, C.E. '23, has been awarded the R. Paul Farrell Award of Merit by the Nashville chapter of the Tennessee Society of Professional Engineers. Crouch has worked for the Tennessee Electric Power Company, the Tennessee Valley Authority, the Nashville Service Pension Board, and is presently serving as planning engineer for the Nashville Electric Service.

David Grone, C.E. '34 was recently named a fellow of the American Society of Civil Engineers. He is a squad leader with Ebasco Services Corporation.

J. D. Tuller, C.E. '09, has formed the Tuller Foundation for the Advancement of Economic Understanding. The purpose of this nonprofit organization is "to promote a better understanding of basic economic facts and principles, to explain how political events affect economics, and to show the social obligations and responsibilities of individuals with regard to the American economic system."

Charles M. Huck

Earl J. Murphy, Jr., C.E. '52, recently assumed the position of city planner of Cleveland Heights, Ohio. Prior to this he had worked for Ebasco Services, Incorporated, Procter and Gamble, and the Rhode Island Development Council.

Charles M. Huck recently opened his own office as a consulting Industrial Designer in New York. Mr. Huck, '54, transferred to the University of Illinois in 1952. He graduated from that school in 1954 with honors in design. At Cornell he was a member of Phi Sigma Kappa and the Savage Club of Ithaca.

D. Verner Smythe, M.E. '28, was written up in *The Rudder* of April 1960. He has been an ardent yachtsman for many years, and he continues to serve the sport as a racing association and regatta official. Mr. Smythe is a partner in the patent firm of Pollardi, Johnston, Smythe and Robertson.

William L. Rogers, M.S. Engr. '39, has been second in command of the Air Force Missile Test Center since March, 1958. Prior to receiving his master of science degree from Cornell, Brig. General Rogers was graduated from the United States Military Academy.

During World War Two, he received the Legion of Merit, the Silver Star and the Commendation Ribbon. In July, 1954, he became assistant for development programming with the Deputy Chief of Staff, Development, at Headquarters, U.S. Air Force, in Washington. He held this position until March, 1958. He was promoted to Brigadier General in October, 1956.

In May, 1958, Brig. General Rogers was awarded an Oak Leaf Cluster to the Legion of Merit for his work at Air Force Headquarters.

Howard B. Maynard, M.E. '23, was recently elected president of the Association of Consulting Management Engineers. Maynard, who has his own consulting firm in Pittsburgh, Pennsylvania, has also served as an officer of other national and international management groups.

Robert H. Olson, Chem.E. '46, is now the superintendent of the molding compound plant of the Toledo, Ohio, Plastics and Coal Chemicals Division of Allied Chemical Corporation. Formerly, he had worked at Allied's Syracuse, New York, Solvay Process Division.

H. W. Hoefer, M.E. '32, was recently named president of Hoefer's ReadyMix, Incorporated, of Columbia, South Carolina. Hoefer also has been elected to the advisory board of the State Bank and Trust Company of Greenwood, South Carolina, and to a directorship of the Five Points Building and Loan Association of Columbia.

Edward Munschauer, A.E. '39, has been appointed director of research of the Niagara Machine and Tool Works. At present he is also a director and the treasurer of the firm.

Correction: March, 1960; Alumni Engineers. Theodore A. Cheney received an A.B. in Geology in 1951 and an A.M. in Geography in 1952 from Boston University.

Alumni News

Edward Munschauer

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PROFESSOR ROBERT A. PLANE

by Daniel D. Thomas, EE '64

Because inorganic chemistry is one of the most basic of all sciences and of great importance to the engineer, every freshman engineering student at Cornell takes a course in introductory inorganic chemistry. But those who plan little or no further work in chemistry, however, could easily find the course somewhat dull were it not for the lively lectures and interesting text by Professors Michell J. Sienko and Robert A. Plane. Years after their first chemistry lecture, engineers will remember Dr. Plane carefully scrutinizing an electrolysis of water experiment and remarking that the Piel's head test was well underway.

In an interview, Dr. Plane revealed many aspects of his personal life that proved as interesting as his lectures. He is originally from Indiana, having received his preparatory education in the school system of Evansville. He received his PhD in chemistry from the University of Chicago in 1951, at the age of twenty-four. After spending a year at Oak Ridge, Tennessee, he came to Cornell as an instructor. He is now an Associate Professor.

Dr. Plane's family numbers four including his wife whom he met at the University of Chicago, a daughter almost five, and a son aged six. Many of his college interests are reflected by his family. He and his wife play a flute-like instrument called a recorder. In fact, Dr. Plane helped meet his college expenses by playing many different instruments including the trumpet, clarinet, and saxophone, as well as announcing in a radio station.

At the present time Dr. Plane's time is divided equally between two chemistry courses and his research projects.

The freshman chemistry course now numbers about 900 students and occupies much of Dr. Plane's time during the first term of each year. In order to accommodate so many students, he gives his biweekly lecture three times on each lecture day. Of course, one is then always amused at the student who has trouble remembering which hour he was originally scheduled for lecture so that on prelim day he may take the right exam. The text which he wrote, in 1955, along with Dr. Sienko, is currently the most popular college chemistry text in the country. It is even used in South Africa and Poland (he jokingly pointed out that just after obtaining publication rights, the Polish publisher was deported to Siberia). An Italian edition is due to appear soon.

This freshman course and book are very different from any chemistry the average student has had in high school. It is for this reason that nearly all students are put on the same initial basis in the course regardless of their high school preparation and regardless of whether they are engineers, agriculture students, or chemistry majors. In fact, Dr. Plane pointed out that those students without any previous chemistry at all usually do as well as everyone else by the end of the course. He believes that for such a diversified group the emphasis should be laid on principles that can remain with the students throughout their school career rather than on methods that might be forgotten. The facts given in the course and the methods learned in a laboratory period serve to make the principles clear and easy to remember.

Prof. Plane

Here, then, is part of the twofold reason why Dr. Plane is pleased that engineers take chemistry. Chemistry is so basic to engineering that the principles learned early will continue to be of use to the engineers. Secondly, this particular course with its large enrollment gives new engineers an excellent opportunity to have more contact with non-engineers, for they will have more contact with these non-engineering chemistry students in later life.

But freshman chemistry, large as it is, is not Dr. Plane's only course. Students doing graduate work in chemistry, agronomy and biochemistry as well as a few seniors meet Dr. Plane in another course, Chemistry 576. It is a small course, numbering only thirty students, so that their advanced work can prove to be of great value to them.

Classes occupy only half of Dr. Plane's time, however. Many persons while crossing Triphammer Bridge at night may have noticed that several of the windows of the Baker Laboratory of Chemistry are lighted with an unusual bright blue light. Few students realize that this light comes from mercury arc lamps connected with Dr. Plane's experimental work in Raman Spectroscopy.

The rest of Dr. Plane's research is concerned largely with properties of aqueous solutions and complex ions, as evidenced by a mass of equipment in a laboratory near his office.

Dr. Plane's future looks to be long and meritorious. Next year he will not be at Cornell. But when he returns to school after having had six months of biochemistry study in Stockholm and another six month's work in spectroscopy at Oxford, he will certainly be even better prepared than ever to resume his many phases of work here at Cornell.

COLLEGE NEWS

C.E. SCHOOL DOES RESEARCH ON REINFORCING BARS

Vital information on the behavior of structures utilizing modern steel reinforcing bars—almost twice the strength of conventional bars—has been compiled in the most modern civil engineering research laboratory in this country, at Cornell University.

George Winter, head of the Department of Structural Engineering, School of Civil Engineering, Cornell, is in charge of continuing research being conducted to make possible the successful utilization of these high-strength reinforcing steels in buildings and bridges.

The Cornell researchers have shown what measures must be taken to limit short-time and long-time deflections of such structures to acceptable values, to keep width of hairline cracks within safe and tolerable bounds, and what methods must be used to calculate the strength of such structures.

EXPERIMENTAL HONORS PROGRAM PLANNED IN CHEM. E. SCHOOL

The School of Chemical and Metallurgical Engineering at Cornell University has established an experimental predoctoral honors program for undergraduate chemical engineering students planning to undertake graduate study for the doctoral degree.

Applicants are now being screened for the program which is scheduled to go into effect next fall. It is designed for undergraduate students who expect to make careers of research and teaching with the principal objective indoctrination in research and the advanced theoretical subject matter normally included as part of the work for the doctoral degree.

Undergraduates interested in the program will apply for admission during their third year so that they may provisionally preregister for a sequence of courses beginning in the fourth year. Final approval for the program will be given at the end of the fourth year. During this provisional period the student must demonstrate initiative in selecting and making plans for a research project which will extend through the fifth year of Cornell's five-year undergraduate chemical engineering curriculum.

There will be no fixed standards for entry into the program. Students requesting admission during their third year will be considered by the entire chemical engineering staff and reviewed again at the end of the first semester of the fourth year.

Applicants must state their intentions to study for the doctorate with the objective of a career in research or teaching. Since four of the courses to be taken during the fifth year are required of doctoral candidates in the Graduate School, students approved for this program must have demonstrated high levels of scholarship in difficult courses, particularly in those that are prerequisites for advanced-level work.

Principal features of the program are a year of mathematics beyond differential equations, a three-term research project and the substitution of theoretical advanced work for some of the "design" courses in the fifth year. Students will be urged to take a foreign language as part of their electives.

CORNELL ARCHITECTS REVEAL PLAN FOR ATTACK-PROOF CITY

The Cornell University College of Architecture has revealed for the first time models and concepts for an entire industrial city that would serve as protection against nuclear attack for 9,000 people and a major industry.

The results of the one-year Cornell study were introduced in the World Affairs Auditorium, United Nations Plaza, to representatives of about 90 organizations, industries and interested groups, and members of press, radio and television.

Prof. Frederick W. Edmondson, Cornell, and graduate students of the College of Architecture, including eight from foreign nations, were on hand to outline the project, based on extensive studies of the Schoharie County area, 25 miles from Albany.

The objective is to prove that survival is possible through constructing nuclear attack-protected cities. Specific problems involved in the research were: to defend a computer plant from such fantastic weapons as guided missiles and 20-megaton bombs, to keep operative an underground computer plant after a thermonuclear attack, and to create defenses that would make a population of 9,000 self-sustaining during and after attack.

With the aid of a number of organizations and individuals, investigations were carried out on the physical effects of a nuclear bomb, psychological and public health factors, structures, civil defense and plant protection, industry and its relation to the community, space requirements, costs, and requirements for specific townsite locations.

Immense psychological barriers prevented the group from planning a community that would be entirely underground. Also rejected were a central community shelter and residential or neighborhood shelters.

The central refuge scheme would entail an extended amount of warning time, the planners decided, and the individual shelter system was eliminated because families might be separated at the time of an alert. Such a system would leave them without communication. A series of neighborhood shelters interconnected by subterranean corridors was decided upon. This system permits people to function as a community during any period of above-ground or underground living.

The facilities for protection against nuclear attack, and biological and chemical warfare were designed so that the bulk of the planned city's residents can live both above and below ground under normal circumstances—so all residents live only underground in the event of disaster—and so that underground disaster facilities serve the city daily in normal times.

The day-to-day acquaintance with the underground facilities by the populace would make the psy-

chological transition to underground living during any disaster period an easy and natural one, the Cornell architects point out.

The general conclusion reached was that reinforced concrete vaults covered with earth would be most suitable for blast-resistant structures. Some five feet of earth plus a foot of adequately structured concrete were found capable of required attenuation and withstanding assumed blast pressures.

After studies, it was decided to design within three miles of Ground Zero, or for 35 pounds per square inch overpressure per structure.

Mass decontamination stations capable of handling 60–75 persons per hour require about 1,700 sq. ft. of space. Such stations have facilities for undressing, disposal of contaminated garments, two or three shower areas, several barbers and monitors, clean towel and clothing storage, radiological equipment, control equipment, dressing space and infirmary.

Wells drilled in the flood plain of Schoharie Creek indicate a flow of 150 gallons of water per minute, a reliable source for an atomic attack-protected community. The depth of the ground water is such that more than two weeks would be required for radiologically-contaminated surface water to enter the water source.

Three protected storage reservoirs, each with 1,000,000-gallon capacity, would be located strategically in the shelter network as an emergency source for 25 gallons per-day, per-capita.

The underground complex would be completely air conditioned and is designed to filter out particles of radioactive fallout materials and biological warfare agents, as well as to retain and neutralize chemical warfare agents. Closed-circuit television designed to serve the school system and to be readily converted to use for both entertainment and education during sub-surface isolation periods is included in the Cornell plan.

A new device with which the group experimented beforehand was a valve closure for shelter entrances. These valves, which have canopy tops, drop down to seal tubes containing spiral entrance stairs and elevators after everyone is safely in shelters.

The Cornell University planners developed the project bearing in mind that man has unleashed a power which can elevate—or exterminate him.

GOLD DISCUSSES ADVANTAGES OF LARGE MHD GENERATOR

The magneto-hydrodynamic generator was the subject of a talk given recently by Professor Thomas Gold before the Ithaca chapter of the American Institute of Electrical Engineers. Professor Gold is a professor of astronomy and electrical engineering and is director of the Cornell Center for Astrophysics and Space Research.

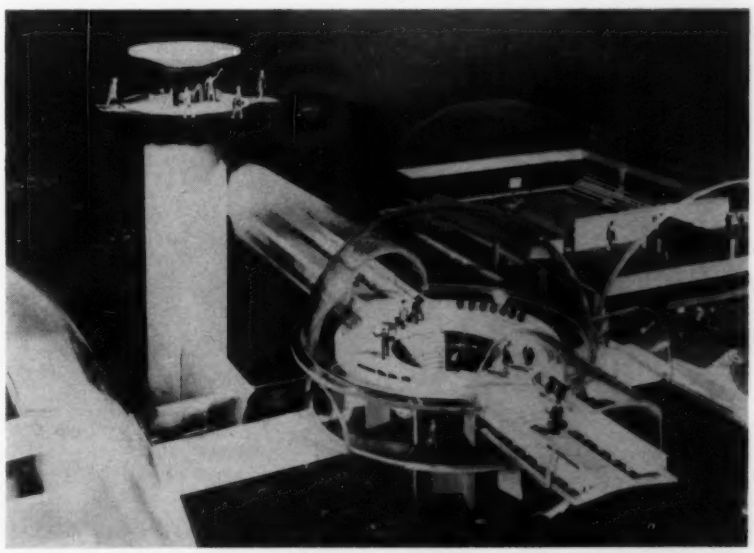
Professor Gold emphasized that power needs are expected to increase rapidly in the near future and larger power plants will be essential. Since the magneto-hydrodynamic principle finds its best applications in large-scale generators, the MHD generator may well be the answer to the problem of supplying the huge amounts of electric power which will be needed in the future.

In a conventional generator, burning coal heats a gas which in turn expands against turbine blades, causing the generator armature to rotate. The rotation causes an emf in the armature windings. In the MHD generator, the middle step is eliminated. Burning coal heats a gas to a temperature high enough to cause the gas to ionize. When the stream of high-temperature ionized gas is directed into a strong magnetic field, a current flow develops perpendicular to the direction of flow and to the magnetic field.

Professor Gold explained that in a typical MHD-generator installation, the gas would be heated to about 5300 F by burning coal. Its temperature would then be reduced to about 4200 F in an MHD generator producing 360 megawatts. The gas would then be circulated through a regenerative heater to warm up the incoming gas. It would leave the regenerative heater at about 2100 F and flow through a conventional generating system which would lower its temperature to about 300 F.

In order for the MHD generator to function, the gas must be ionized to a large extent. The minimum temperature necessary for large-scale ionization is about 4200 F, and the gas should not leave the MHD generator at a temperature lower than that.

Professor Gold emphasized that the main problem with research on the MHD generator is that of making a model big enough. Avco Manufacturing Company has developed a small working model



An entry valve (left) to the underground part of the atomic attack protected city would look like this. The lower disc at the top of the tubular entrance represents the ground level in the cutaway model. In the event of an attack warning, the upper disc would move downward, sealing the entrance after residents were safely underground.

which is behaving exactly according to theoretical predictions, but, because it is small, it is still very inefficient. Professor Gold stated that eventually some company will have to finance the construction of a large-scale MHD generator, having no concrete assurance that such a large installation will operate according to the theoretical predictions.

SERIES OF LECTURES ON COSMOLOGY GIVEN IN APRIL

Several of the world's leading cosmologists delivered lectures on space-related subjects in non-technical language aimed at both the laymen and scholars at Cornell University during April.

Cornell's Department of Astronomy arranged a series of four lectures. One by Prof. Edwin E. Salpeter, Cornell University nuclear physicist and space specialist, covered "Age and Evolution of Our Galaxy." Professor Salpeter revealed unpublished observations concerning the age of this universe based on a recent study in which he participated. According to him, there may be some clusters which are over 20 billion years old.

Three of the speakers are members of the famous "Cambridge Group." Professor Gold discussed "The Steady State Universe and the Condensation of Galaxies," and Professors Bondi and Lyttleton are the members who were on hand. The "Cambridge Group" also includes Prof. Fred Hoyle, who was unable to attend.

The four space experts, who attended the University of Cambridge, England, simultaneously, have contributed more valid, new space theories than perhaps any other group of contemporary scientists. They are the youngest of the scientists who have achieved world recognition as space cosmologists.

"Relativity" was discussed by Prof. Hermann Bondi, of King's College, London, who is currently a visiting professor at Cornell University. With Prof. Thomas Gold, director of Cornell's Center for Radiophysics and Space Research, he is co-originator of the steady state universe theory, which opposes the older concept that the universe was formed by a tremendous explosion.

Prof. Ray A. Lyttleton, Cambridge University, who is a special lecturer for the Cornell Center for Radiophysics and Space Research, discussed "Electrical Universes," a subject closely related to Professor Bondi's topic. The two men jointly made a study recently and published a paper on relativity and the electrical universe.

The electrical universe, a theory which is in the process of being investigated says that in very large regions of space, there is either an overabundance of positive charge or else, the charge on the proton is not exactly equal to the charge on an electron. These possibilities explain the tension force necessary if the universe which seems to be expanding away from us is not to become an "empty space" in a few billion years. The excess of positive charge would cause nearby stars and groups of stars to repel each other with a force stronger than gravitational attraction and thus expand.

The effect which allows globular clusters to exist, i.e., groups of stars, is the fact that in highly ionized regions of the universe, the great attraction of the free electrons for the free protons is greater than the excess positive charges which might cause them to expand also. The excess charge is "blown off," and the attractive forces revert to gravitation. Professor Lyttleton said that even if it is proved that protons do have the same charge as electrons, it will take a long time before it is disproved that there is an excess of positive charges in the universe. Thus, the electronic universe theory will continue to aid man in his search for the answer to the beginning of the universe.

WRIGHT, HEAD OF SPONSORED RESEARCH AT CORNELL TO RETIRE

Theodore P. Wright, Vice President of Cornell University in charge of the administration of sponsored research during a spectacular 12-year period of growth, will retire July 1, 1960, it was announced by Deane W. Malott, Cornell president.

Under Vice President Wright the dollar volume of sponsored research at Cornell rose from $9 million in 1949 to more than $30 million in 1959 in a broad range of research projects including many in the fields of agriculture, engineering, medicine, nutrition, physical and biological sciences, social sciences, veterinary medicine, the humanities, and aeronautics.

The retiring Cornell research vice president pointed out that "although the statistics are not yet complete, the indications are that the dollar volume of sponsored research will increase an additional 10 percent in 1960."

Dr. Wright also served Cornell as president and chairman of the Board of Directors of the Cornell Aeronautical Laboratory in Buffalo where the research program increased from 3½ million dollars to more than $16 million. He also has served as president of the Cornell Research Foundation and for six months in 1951 he was acting president of the University.

Dr. Wright has made aviation his life work. He sponsored development of the electrical full-feathering propeller, has received many medals and awards for his work in the aviation industry and has written more than 150 articles, speeches and technical papers relating to aviation.

Born May 25, 1895 at Galesburg, Illinois, Dr. Wright received a Bachelor of Science degree from Lombard College (later merged with Knox College). He was awarded a B. S. degree in Architectural Engineering from Massachusetts Institute of Technology in 1918. He received an honorary Doctor of Science degree from Knox College in 1937 in recognition of his "distinguished service to aeronautics." He and Mrs. Wright have two sons; one, Douglas (Cornell '42) is a civil engineer in Boston, and the other, Ted Jr., an assistant professor of international relations at Bates College, Maine.

On retirement, Dr. Wright will continue as a trustee of the Power Reactor Development Corporation and a member of its Safety Committee; and as a consultant to the Reaction Motors Division of the Thiokol Chemical Corporation. He said that he intends to do some writing and will edit for publication the many papers he has written.

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NEW 160-FOOT LENS TUNNEL BEING BUILT

A 160-foot lens tunnel is one of many special research features being built into a new eight-story physics building at Kodak Research Laboratories in Rochester, New York. The tunnel will be used in research on lenses and optical systems. Its length is essential because in testing a new lens design, an observer or instruments must be far enough from the light source to have it appear as a single point of light. The tunnel is insulated and covered with three feet of earth to keep interfering heat waves to a minimum. The tunnel is located at basement level, outside the building proper, so that it will be free of vibrations from street traffic that might affect delicate measuring instruments.

RAILROADS—WILL COAL REIGN ONCE MORE?

Diesel locomotives will someday go off their liquid diet and turn to atomic power or the old standby —coal.

"All train engines will someday change from burning oil to more effective and economical fuels, such as coal, electricity, or possibly atomic power," according to Albert L. Merriam, Chairman of the Railroad Community Committee of the Southern Tier, Elmira Section, New York State.

The rail industry is carrying on continuous experiments with new forms of motive power in its research and development program. Further electrification of rail lines is a possibility because technical problems caused by required high distribution voltages have been solved. Atomic locomotives might haul trains of the future if the contamination danger can be eliminated. However, according to a committee spokesman, "Some industry leaders believe coal-burning diesels, now under development, will bring the railroads back to their traditional fuel."

SUBMINIATURE CIRCUIT BREAKER HAS BUILT-IN INDICATOR LIGHT

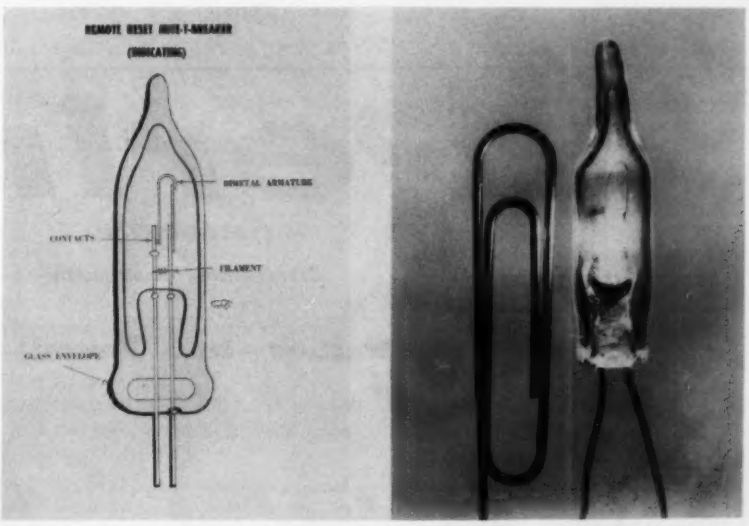
A remote reset circuit breaker with a built-in indicator light for use in low voltage circuitry has been introduced by Sylvania Electric Products Inc. The new circuit protector is a subminiature device one and one-quarter inches long and one-quarter inch in diameter. It is vacuum sealed in a glass envelope and contains a tungsten filament that becomes incandescent when the circuit is broken. With the circuit open, the filament produces sufficient light to act as an indicating device. The heat from the incandescent filament serves to keep the breaker open.

The filament is connected in parallel to the contact, which is a bimetallic strip. When the circuit is overloaded, the strip curls and breaks the circuit, forcing all the voltage through the filament. The current drawn by a tripped breaker to illuminate the filament is approximately 200 milliamperes. In order to reset the breaker it is necessary only to open the line switch and remove the short or overload. The breaker will reset itself in less than a minute, after which the line switch may again be closed.

The remote reset circuit breaker can be operated at six to twenty-four volts AC/DC and will be available in a range which holds from one to five amperes and which trips at double the amperage. At seventy-eight degrees Fahrenheit the tripping time ranges from five to forty seconds. External heat will trip the breaker at 200 degrees Fahrenheit, making it useful in fire alarm systems, as well as appliances and electronic equipment.

MOISTURE GETTERS FOR SEMICONDUCTORS

Development of tiny moisture getters for semiconductors was recently announced by Corning Glass Works. The getters comprise the initial volume application of the company's porous or "thirsty" glass.



Sylvania's new circuit breaker has a tiny filament mounted within its evacuated glass envelope (left). When circuit is overloaded, the bimetallic element opens, breaking the circuit. At the same time, a 200 milliampere current charges the filament, providing an indicator light (right) and holding the breaker open.

The getters are made from a porous 96 percent silica glass. An advantage of the material besides its ability to absorb moisture is its mechanical strength. This allows easy handling and mounting of the getters in transistors and diode enclosures.

Getters are placed in semiconductor enclosures because of a tendency of such devices to become less efficient in the presence of moisture, even if present in minute quantities. The "thirsty" glass that is used contains billions of submicroscopic holes that have an average diameter of about forty angstrom units, or one-sixth of one-millionth of an inch. One pore would have to be enlarged 12,000 times to admit a human hair.

The getters are available immediately in the form of discs, with or without holes, in thicknesses of 0.030 inches or more. Large quantities can be produced in a three week period to meet any other design requirements.

DEVELOPMENT OF LOW-COST DESKTOP COMPUTER ANNOUNCED

Electronic analog computers are now within the price range of even the smallest of the nation's engineering firms. What is more, they can "grow" by the addition of components with the expanding needs of a firm, according to the manufacturer, Applied Dynamics, Inc., a subsidiary of the Bowmar Instrument Corporation.

The basic unit is about the size of a television set and is priced to sell as low as $2000. Although other analog computers have been reduced to desktop size, the new unit has the added feature of expandability. This feature is becoming increasingly important to small firms whose research and computation needs grow almost overnight. The new computer can be expanded in utility and capability by the simple procedure of plugging in additional modules or even an entire additional cabinet, like "building blocks."

The science of analog computation is of much more recent origin than the more familiar "digital" computation. First developed in the 1930's as a means of electronically simulating problems of aircraft flight, analog computers have been quietly making a host of vital contributions to the fields of design and control, including the famous Norden bomb sight, shipboard gunnery systems, lock-on-target systems in fighter aircraft, and numerous pilot training devices.

In contrast to the digital data processing computers, the analog system is an actual "electronic model" of the problem under study; i.e., the electronic circuitry is designed to be directly "analogous" to the aircraft, missile, ship, etc., which is being built, as well as the forces such as weather, shock, friction, etc., to which it will be subjected. Through this method, design engineers have been able to "test" projects before they are constructed.

NEW ORLEANS EXPRESSWAY —SOMEBODY GOOFED!

The city of New Orleans has a new multiple-lane expressway connecting with the eight-lane Airline Highway to Baton Rouge on the west, and crossing the Mississippi River into Algiers on the East. The road is a marvel of engineering. The trip through the city on the expressway takes about eight minutes, compared to the old time of about an hour.

Although the engineers have, on the whole, done quite a commendable job, there is a glaring mistake near the western end of the expressway—a mistake which should never have gotten past the drawing board. If one is traveling north toward the expressway on one of the more heavily traveled streets and wishes to get on the expressway with the ultimate aim to go west on the Airline Highway, he will find it impossible, for, although there are adequate signs pointing the way, one must cut across three diverging lanes of forty-five-mile-an-hour traffic within a space of 100 yards to follow the signs; Miraculously, the mistake was discovered before there were any accidents, and now each lane is separated at this point by sandbag barricades. The highway department is now trying to figure out a way to remedy this embarrassing situation.

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FIFTY YEARS AGO IN THE ENGINEER

The way in which conservative astronomers regard the various proposals to communicate with Mars by means of wireless signals, or lights, may be judged from the reception given to a proposal at the last meeting of the Astronomical and Astrophysical Society of America, that the society should go on record as deeming any attempt to communicate with Mars unpracticable at the present time, and as deprecating the use of any funds for such a purpose. The proposal was voted down, but the members present were unanimous in the belief that such attempts are useless, and at the same time were of opinion that it would not be wise "to dignify with any formal action the absurd accounts that have recently appeared in the newspapers."—*Sibley Journal*—May, 1910.

A one-mile cable span has recently been completed at the northern extremity of San Francisco Bay. Owing to the rocky character of the bottom, high tension power submarine cables were considered impractical and the Pacific Electric Company therefore decided upon an aerial cable transmission of the power. One of the towers erected is 225 feet high and the cable at its lowest point allows a clearance of two hundred feet above the water. *Sibley Journal*—April, 1910.

In all delicate scientific work of the laboratory you have noted the presence of the personal factor. After you leave these halls you will find that factor of increasing moment as the scope of your work broadens, and I make bold to say that the personal factor will have more to do with your success than any one element on which you can put your finger. Moreover you are at present developing your individual personal equations in some direction or other. Just now your personal equation has to do with the relations between you and your studies.

It is probable that a great many of you have noted at some time the division of opinion in regard to the benefits of a college education. A number of the so-called "self-made men" have come out flatly against college education. They tell you it is unpractical, that you become soaked in theory and purely theoretical methods of thought. I used the adjective "so-called" advisedly for in a larger sense we are all self-made. You learn little except of your own volition, your fund of experience grows only as you take to yourselves and make your own the lessons of cause and effect. You and the unschooled engineer grow by the same processes, the difference being merely one of opportunities. Given the spur felt by the self-taught engineer, the college man can so far outdistance him in the end that the comparison is hardly fair. But with the advantages of college is apt to come a false perspective that is a handicap. There is a tendency to feel that your equipment will be such that to a certain extent results will come of themselves. And yet your equipment may be of as little use to you as a Maxim gun to a South Sea Islander.

Your task at present is a dual one, to acquire knowledge and to learn to use that knowledge. And the greater emphasis should perhaps be put on the latter side of the task. *The Cornell Civil Engineer*—April, 1910.

Only a few months ago operations were commenced on the concrete work of the Panama Canal. This work embraces six huge locks; three being at Gatun on the Atlantic side, one at Pedro Miguel and two at Miraflores on the Pacific side of the isthmus. The concrete construction is of the most massive character, far outclassing the Pyramids of Egypt or the Great Wall of China. All of the locks are 100 feet wide and 1,000 feet long with a depth over the sills of 45 feet. The three locks at Gatun are a huge mass of concrete, being one continuous structure with a total length of 3,800 feet. The Pedro Miguel lock and piers have a length of 1,800 feet, while those at Miraflores are 2,800 feet long. It has been estimated that 8,000,000 cubic yards of concrete and 900,000 tons of cement will be needed in the construction of these locks. The materials for these gigantic operations are brought from different points along the coast. The crushed stone is taken from Porto Bello some 20 miles east of Colon. The rock is obtained from the quarries by steam shovels and sent by gravity to giant crushers from which it is delivered as before to the barges. The sand is obtained from Nombre de Dios about 40 miles along the coast from Colon. The report for December, 1909, shows a total excavation amounting to 2,618,662 cubic yards. The material placed in dams, mainly at Gatun, amounted to 340,610 cubic yards while 57,265 cubic yards of concrete were built up in place. *The Cornell Civil Engineer*—April, 1910.

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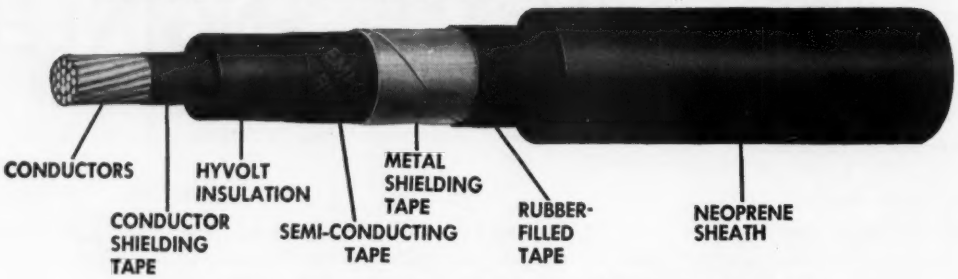

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STRESS *and* STRAIN . . .

She (gushingly): "Will you love me when I'm old?"

He: "Love you? I shall idolize you. I shall worship the ground you walk on. I shall-er-ah, you're not going to look like your mother, are you?"

• • •

The professor grimly eyed the class as he prepared to return a batch of examination papers. "You will remain seated while they are passed out," he commanded. "If you were to stand, it is conceivable that you might accidentally form a circle. That would make me liable for arrest."

"Why?" the E.E.'s wanted to know.

"I could be arrested for maintaining a dope ring."

• • •

Once upon a time there were three bears. One morning they came down to breakfast and Papa Bear looked at his bowl and cried, "Someone's eaten my porridge."

Baby Bear looked at his bowl and cried, "Someone's eaten all my porridge."

"Sit down and shut up," said Mama Bear. "It ain't poured yet."

• • •

She: "I don't believe you know what good clean fun is."

E.E.: "All right, what good is it?"

• • •

The designer sat at his drafting board;
A wealth of knowledge in his head was stored;
Like "What can be done on a radial drill,
Or a turret lathe or a vertical mill?"
But above all things, a knack he had
Of driving gentle machinists mad.
So he mused as he thoughtfully scratched his bean,
"Just how can I make this thing hard to machine?"
If he made this body perfectly straight,
The job had ought to come out first rate.
But t'would be so easy to turn and bore
That it would never make a machinist sore.
So he'll put a compound taper there,
And a couple of angles to make 'em swear,
And brass would work for these little gears,
But it's too damned easy to work, he fears.
So just to make the machinist squeal,
He'll make him mill it from tungsten steel!
He'll put those holes that hold the cap
Down underneath where they can't be tapped;
Now if they can make this, it'll be just luck,
'Cause it can't be planed and can't be ground,
So he feels his design is unusually sound,
And he shouted in glee "Success at last!
This damned thing can't even be cast."

• • •

A preacher was hearing confession. In the middle of it, he stopped the young sinner saying, "Young man you ain't confessin', you's braggin'."

• • •

Arriving at a strange hotel, a fussy woman thought she'd better know where the fire escape was. So she started exploring. During her tour, she opened a door and found herself in a bathroom occupied by an elderly gentleman.

"Oh, I'm sorry!" she twittered. "I was looking for the fire escape."

Continuing her search, she presently heard the pad of bare feet behind her and a shout made her turn. It was the elderly man, clad in a bath towel.

"Wait a minute!" he gasped. "Where's the fire?"

• • •

The South American dictator was reviewing his troops. He heard a soldier sneeze. "Who sneezed?" he demanded. Silence. He asked again, and when he received no reply, he ordered that the first rank of men be shot. Then he asked again, "Who sneezed?" No answer. The second rank was demolished. "Now maybe someone will confess," the dictator said. "I did it," a soldier in the third rank admitted. "Aha," said the dictator, "Gesundheit!"

• • •

A spy was being led to his execution by a squad of soldiers on a cold rainy morning.

"You soldiers are barbaric," the spy grumbled, "to make me march through this cold rain like this."

"Quit squawking," snapped one of the soldiers, "we've got to walk back."

• • •

A young C.E. was proudly showing the Governor his first project, a three million dollar dam. The Governor stared in amazement and exclaimed, "Migawd, the water—it's supposed to be on the other side."

• • •

Then there was the nervous June bride who didn't know whether to say, "I do," "I have," or "I will."

• • •

E.E.: "Who spilled mustard on my waffle?"

Wife: "Oh, John! How could you? This is lemon pie."

• • •

"Your girl is spoiled, ain't she?"

"Naw, that's just the perfume she's wearing!"

• • •

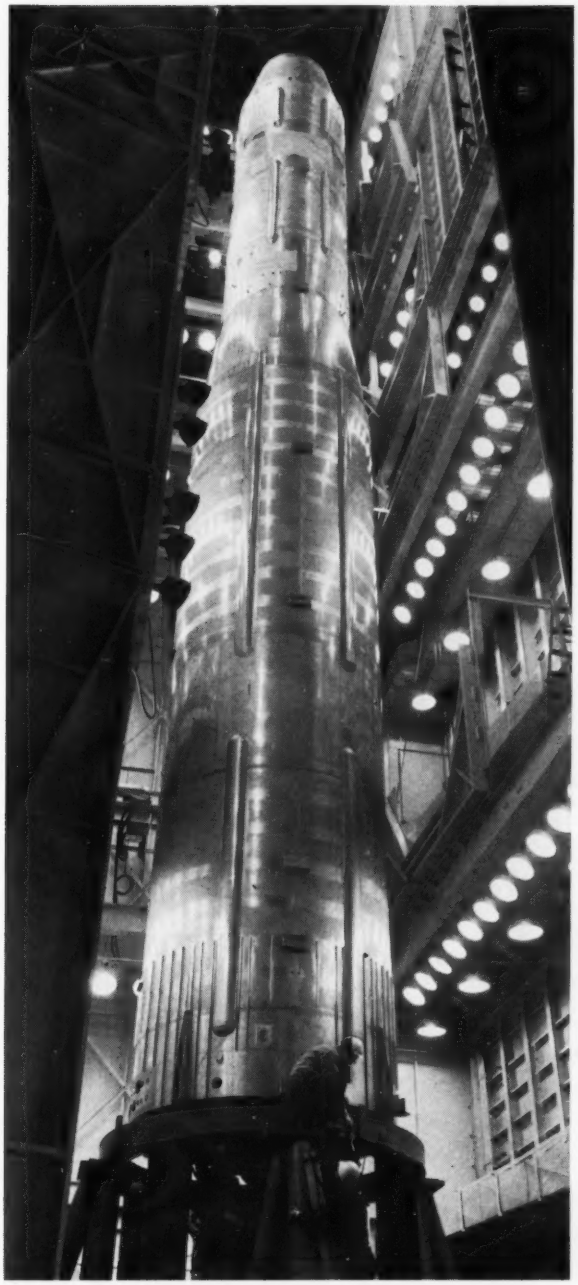
A window washer related this experience to his friends:

"One day I was cleaning a window when a young woman entered and started to undress. She took off her shoes and stockings and then her dress, when suddenly the ladder broke."

"What a calamity at a time like that," remarked one of the listeners.

"It sure was," answered the window washer, "but what could you expect with twenty guys on the ladder?"

If your sights are set on outer space–



U.S. Air Force I.C.B.M. "Titan" shown in the vertical test laboratory at the Martin Company, Denver, Colorado.

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One of a series

Interview with
General Electric's Byron A. Case
Manager—Employee Compensation Service

Your Salary at General Electric

Several surveys indicate that salary is not the primary contributor to job satisfaction. Nevertheless, salary considerations will certainly play a big part in your evaluation of career opportunities. Perhaps an insight into the salary policies of a large employer of engineers like General Electric will help you focus your personal salary objectives.

Salary—a most individual and personal aspect of your job—is difficult to discuss in general terms. While recognizing this, Mr. Case has tried answering as directly as possible some of your questions concerning salary:

Q Mr. Case, what starting salary does your company pay graduate engineers?

A Well, you know as well as I that graduates' starting salaries are greatly influenced by the current demand for engineering talent. This demand establishes a range of "going rates" for engineering graduates which is no doubt widely known on your campus. Because General Electric seeks outstanding men, G-E starting salaries for these candidates lie in the upper part of the range of "going rates." And within General Electric's range of starting salaries, each candidate's ability and potential are carefully evaluated to determine his individual starting salary.

Q How do you go about evaluating my ability and potential value to your company?

A We evaluate each individual in the light of information available to us: type of degree; demonstrated scholarship; extra-curricular contributions; work experience; and personal qualities as appraised by interviewers and faculty members. These considerations determine where within G.E.'s current salary range the engineer's starting salary will be established.

Q When could I expect my first salary increase from General Electric and how much would it be?

A Whether a man is recruited for a specific job or for one of the principal training programs for engineers—the Engineering and Science Program, the Manufacturing Training Program, or the Technical Marketing Program—his individual performance and salary are reviewed at least once a year.

For engineers one year out of college, our recent experience indicates a first-year salary increase between 6 and 15 percent. This percentage spread reflects the individual's job performance and his demonstrated capacity to do more difficult work. So you see, salary adjustments reflect individual performance even at the earliest stages of professional development. And this emphasis on performance increases as experience and general competence increase.

Q How much can I expect to be making after five years with General Electric?

A As I just mentioned, ability has a sharply increasing influence on your salary, so you have a great deal of personal control over the answer to your question.

It may be helpful to look at the current salaries of all General Electric technical-college graduates who received their bachelor's degrees in 1954 (and now have five years' experience). Their current median salary, reflecting both merit and economic changes, is about 70 percent above the 1954 median starting rate. Current salaries for outstanding engineers from this class are more than double the 1954 median starting rates and, in some cases, are three or four times as great.

Q What kinds of benefit programs does your company offer, Mr. Case?

A Since I must be brief, I shall merely outline the many General Electric employee benefit programs. These include a liberal pension plan, insurance plans, an emergency aid plan, employee discounts, and educational assistance programs.

The General Electric Insurance Plan has been widely hailed as a "pace setter" in American industry. In addition to helping employees and their families meet ordinary medical expenses, the Plan also affords protection against the expenses of "catastrophic" accidents and illnesses which can wipe out personal savings and put a family deeply in debt. Additional coverages include life insurance, accidental death insurance, and maternity benefits.

Our newest plan is the Savings and Security Program which permits employees to invest up to six percent of their earnings in U.S. Savings Bonds or in combinations of Bonds and General Electric stock. These savings are supplemented by a Company Proportionate Payment equal to *50 percent* of the employee's investment, subject to a prescribed holding period.

If you would like a reprint of an informative article entitled, "How to Evaluate Job Offers" by Dr. L. E. Saline, write to Section 959-14, General Electric Co., Schenectady 5, New York.

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